



**INSTRUCTION MANUAL FOR THE COLLINS
COMPREHENSIVE PULMONARY LABORATORY
(CPL and CPL_{pf})**

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SECTION ONE -- CPL HARDWARE

Description

1. *Hardware* refers to the physical aspects of the CPL (Comprehensive Pulmonary Laboratory), which contains the instrumentation used to conduct the tests described in the PLUS Software Manual.

The CPL was initially run under PLUS version 3.3, which is a DOS program. PLUS 3.3 includes pulmonary function testing, exercise testing and body plethysmography (non-digital), which are described in the PLUS Instruction Manual for version 3.3 (#760089).

The CPL_{pf} is dedicated to pulmonary function testing and does not include exercise and plethysmography. PLUS/2000 software is designed to run the CPL under Windows 2000, as described in the PLUS 2000 Software Manual.

This manual covers the hardware for both the CPL and CPL_{pf}. CPL will be used from now on to refer to both systems, except where noted.

2. The primary components comprising the CPL system are described below.

Spirometer: Stead-Wells, dry-seal, 10-liter spirometer for measuring flows and volumes in pulmonary function testing.

Balloon Valve: Automates a variety of pulmonary function test procedures.

MicroTach: Allows pneumotach-based spirometry with the CPL. Measures flow directly and integrates flow to arrive at volume measurements.

Gas Analyzers: The analyzers, which are located internally, are used to analyze the gas content of patient breath samples in particular tests, such as FRC, Diffusion and Exercise testing. The CPL contains a He (helium) analyzer, O₂ (oxygen) analyzer and the microGA Multiple Channel analyzer. The latter measures the fraction of CO₂ (carbon dioxide), CO (carbon monoxide) and CH₄ (methane) in each patient breath or in the calibration gas mixture during diffusion testing.

3. The computer, monitor and printer, along with the CPL unit, make up the entire CPL system. Refer to Section One of the PLUS 2000 manual for computer system requirements.



Figure 1-1. The Collins CPL System

Manuals

There are two manuals for the CPL_{pf} system:

- a. The **CPL and CPL_{pf} operation manual**, which you are now reading
- b. The **PLUS 2000 software manual**, which comes with the CPL manual in your shipment.

The **CPL manual** describes such things as system installation, testing setup, maintenance and troubleshooting.

The **PLUS 2000 manual** describes all aspects of the software, including patient testing, configuration and reports.

NOTE:

If you have the CPL system, you will have the PLUS Instruction Manual for version 3.3 (#760089) instead of the PLUS 2000 software manual.

CPL Technical Specifications

Dimensions	27"W x 15.5"H x 17.25"D
Weight	65 lbs.
Classification	Class I Continuous Use with Short-Time Loading Type B Applied Part Equipment not suitable for use in the presence of a FLAMMABLE ANAESTHETIC MIXTURE WITH AIR or WITH OXYGEN or NITROUS OXIDE
Electrical Requirements	115 - 240 VAC 50 - 60 Hz, 3.15 Amps
Fuse Type and Rating	T3.15AL 250V
Operating Environment	Temperature, 13 to 46 °C (55 to 105 °F) Relative Humidity, 0% to 95%
Storage and Transportation Environment	Temperature, -40 to 70 °C (-40 to 158 °F) Humidity, 10% to 90% (non-condensing)
Gas Analysis Bench (CO, CH₄, CO₂)	
Type	Infrared (NDIR)
CO, CH ₄ Range	0-3000 PPM
CO ₂ Range	0-15%
Response	< 100 msec
Sample Rate	100 Hz
Accuracy	1%
Linearity	<1%
Noise	<1% Full Scale
Oxygen Analyzer	
Type	Electrochemical
Range	0.1-100% O ₂
Accuracy	1%
Response	80 ms
Helium Analyzer (FRC)	
Type	Thermal Conductivity
Range	0-20% He
Response	<1.5 Sec (ATS)
Linearity	1%
Accuracy	0.2% Full Scale
Drift	<1% (24 Hrs.)
Volume/Flow Specifications	
Spirometer (Type Stead-Wells)	Dry Seal
Capacity	10 Liter Volume +/- 15 L/sec. Flow
Linearity	0.1%
Frequency Response	Flat to 4 Hz
System Resistance without Valve	< .5cm H ₂ O/L/sec
System Resistance with Valve & DC-2 Filter	< 1.5cm H ₂ O/L/sec
Static Load	< 0.2 cm H ₂ O
Sample Rate	200 Hz, 12 bit A/D

Pneumotach (Collins MicroTach)

Type of Pneumotach	Collins MicroTach
Linearity	2%
Resistance	< .5 cm H ₂ O/L/sec
Accuracy	+/- 3%
Flow Range	+/- 15 L/sec

A/D Converter

Input	12 Bit
Resolution	5 mvolts

Calibration

Analyzers	Autocal of gains, delays, and response times under software control.
Volume	3-liter calibration syringe
Mouth Pressure	Water Manometer 0-10 cmH ₂ O

Hardware Options

Computers	Pentium Computer - Typical
Printers	Windows® 2000 Compatible Color Printer
Monitor	SVGA

Tests Performed

Spirometry
Lung Volumes (Helium Dilution)
Diffusing Capacity (Single Breath DLco)
Static Compliance (Optional)
Gas Exchange
Bronchoprovocation

Test Gases

Type	Specifications	Fitting
Oxygen	99.6% by volume	CGA #870
Helium	99.9% by volume	CGA #930
Lung Diffusion	0.3% CO, 0.3% CH ₄ , 21% O ₂ , Bal N ₂ by volume	CGA #973
CPX Span Gas	5% CO ₂ , 15% O ₂ , Bal N ₂ by volume	CGA #973

Safety Precautions

This section discusses certain safety precautions:

The Collins CPL module has been tested and certified to be compliant to UL2601-1 and CAN/CSA C22.2 NO. 601.1. Class I equipment electric shock protection is provided by 3-wire power cord earth ground and additional external earth ground as described. However, the following precautions must be observed for auxiliary equipment:

- a. Use of a non-601 or non-Class II approved computer, connected to the system from outside the patient environment, requires external ground connection from CPL to earth ground.
- b. Use of a non-601 or non-Class II approved computer, connected to the system from within the patient environment, requires external ground connection from CPL to earth ground .

And

An external ground connection from the computer to the ground.

Collins has provided the necessary grounding equipment and instructions with its systems.

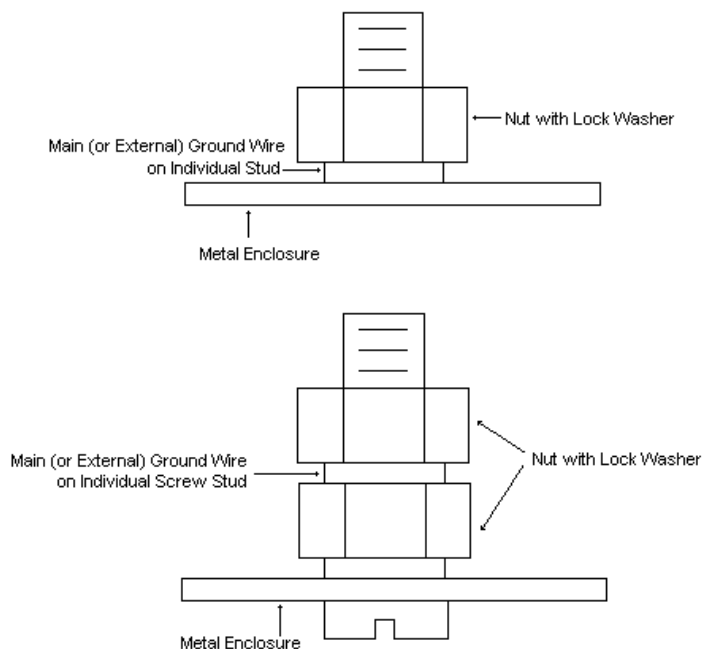


Figure 1-2. External Ground Configurations
Reference Collins Ground Wire Kit Instructions #700887

- c. The power cord for each component must be individually connected to a wall source.
- d. Do not connect extension cords to the system.
- e. Multiple protable socket outlets are not to be used.
- f. Operate the CPL system only when the power cords are plugged into "U" grounded outlets (3-holed outlets).
- g. Unplug the power cords in the event that any servicing is required.
- h. The computer, monitor, printer and CPL testing unit are fit for use within the patient environment provided external grounding has been implemented per instructions.

- i. The User/Operator must not touch any non-medical device (that is, any device other than the CPL testing unit) and the patient at the same time.
- j. The CPL unit has been tested and meets the latest EMC requirements for immunity and emissions of IEC 60601-1-2:1998, Draft 2nd Ed. If for some reason you are having problems with interference, contact the Service Department at 800-635-3200. Examples of occurrences that could interfere with testing include: power supply transients, magnetic interference, mechanical interaction, vibration, thermal radiation and optical radiation.
- k. Do not connect items that are not specified as part of the CPL system.
- l. Do not operate the CPL or other system components on any voltage other than that specified.
- m. When connecting non-medical equipment be sure that total leakage current of combined systems does not exceed the limit concerning combined systems stated in IEC 60601-1-1. Refer to the figure below for the leakage testing configuration. Leakage testing must be conducted by qualified personnel only.
- n. All flammable materials must be kept away from the equipment and No Smoking signs must be prominently displayed in the testing area.
- o. Oil and grease must be kept away from oxygen equipment.
- p. Oxygen-approved regulators must be used for O₂ tanks.
- q. The CPL packaging is recyclable (corrugated cardboard, wooden pallet and plastic bubble wrap) in many locations. Otherwise, packaging can be disposed of through normal waste disposal methods according to local regulations. The accessories used are disposable at their respective ends-of-life as normal waste. This includes the filters, MicroTachs, breathing tubes and calibration syringe. The printed circuit boards can easily be removed from the interface and disposed of separately according to local guidelines concerning printed circuit boards.
- r. Good hygiene practice when handling used filters and/or mouthpieces mandates not touching the parts that came into direct contact with the patient's mouth or aerosolized droplets from the patient's effort. Dispose of filters and mouthpieces as ordinary waste, or as specified by your institution.

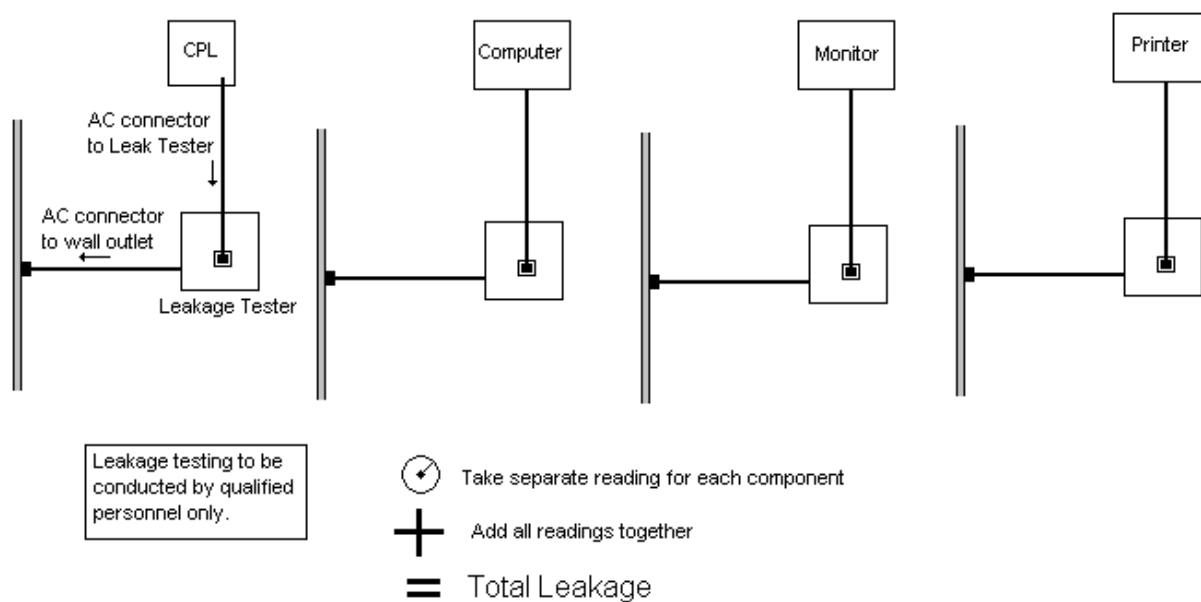


Figure 1-3. Leakage Testing Configuration

Labeling Glossary

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

CAUTION statements identify conditions or practices that could result in damage to equipment.

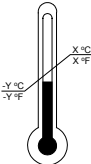
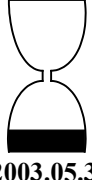
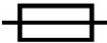
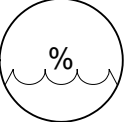
	High Voltage		Item for single use (do not use more than once)
	Attention: Consult Accompanying Documents		Indicates the upper and lower temperatures allowed for transport and storage.
	Protective Earth Ground		Indicates the date by which the product must be used, in the format Year.Month.Date
	Type of Applied Part – B: Equipment providing a particular degree of protection against electric shock, particularly regarding: Allowable leakage current and Reliability of the protective earth connection (if present)		Heavy Weight
	Fuse		Fragile
	Alternating Current		Keep Dry
	Direct Current		Transport and storage humidity conditions
	Power ON		
	Power Off		

Figure 1-4. Glossary of Common ISO Symbols

Installation

Preparation

1. *This section describes how to prepare for installation, unpack and position the CPL and related accessories. The actual installation procedure follows this section.*
2. Have the following in mind when preparing an area for system installation:
 - a. Identify an area for location of the CPL, computer, monitor, keyboard, mouse, and printer.
 - b. If you will be using a table or the optional cart, verify that there is sufficient area, height, and placement to provide an optimum workflow between keyboard information entry, patient positioning, and patient traffic.
 - c. Consider cable lengths, doorways, traffic areas, patient placement, and equipment usage.
 - d. Discuss alternatives with your department head before setting up the equipment.
 - e. If a situation requires additional materials (such as a worktable or movement of equipment within the department), start this process immediately to avoid prolonged installation delays.

Unpacking

1. The CPL comes packaged in two boxes. One contains the CPL body, identified by the serial number on the outside. The other box contains the parts and accessories.
2. Place the CPL box on the floor and open it from the top.
3. Remove the foam packaging pillow from the top of the CPL.
4. Lifting and removal of the CPL from the box requires two people, one at each narrow end of the box. Each person should reach down into the box and grasp the CPL unit from the bottom, then carefully lift it up out of the box. Place it on a level surface.
5. Place the accessories box on a level surface and open it from the top. Carefully remove the contents, being sure to examine all packing materials for small parts before discarding.
6. Inspect all equipment for damage. Even though, before leaving the factory, all Collins instrumentation and related equipment have met strict mechanical and electrical quality control standards as of the date of manufacture, damage sometimes occurs during shipping. Should any damage be found, contact the Customer Service Manager at 800-635-3200 or your local distributor for further handling instructions.
7. Make sure all packing materials are removed from the boxes before any attempt is made to assemble or start up the equipment.
8. When unpacking, be sure to keep all equipment, accessories and cabling out of high traffic areas.

Moving the CPL

1. To move the CPL from one location to another, first make sure that all cables and power cords are unplugged and that they are kept free of the unit so as not to be damaged.
2. If you have the CPL cart, which is equipped with rollers, you may move the CPL by grasping the handle and pushing or pulling the cart.
3. If you do not have the CPL cart, have two people, one on each end of the CPL, lift the unit up from the bottom and carry it to the desired location, begin sure to place it down gently on an even surface.

Cable and Power Cord Connections

1. The CPL system is installed by a Collins representative. However, at some point you may need to relocate or reload your system. For this purpose, the cabling and setup procedures are described below.
2. The following cabling instructions and accompanying diagram represent a sample cabling configuration. Keep in mind that depending on the computer configuration, yours may be different.
3. In addition to the Safety Precautions at the beginning of this section, observe the Caution note below.

CAUTION:

- a. Whenever the system or parts of it are to be moved, make sure to disconnect the appropriate cables in order to avoid damaging them.
 - b. Do not place the CPL directly in the flow path of an HVAC duct, as this may cause premature wear of the spirometer bell.
4. The first step is to connect all system components to the computer via the cables provided.
 5. Plug the cables of the computer keyboard and the mouse into the circular ports reserved for them at the rear of the computer.
 6. Plug the video monitor cable into the adapter reserved for the monitor on the rear of the computer. Secure the screws at both ends of this connector and all similar connectors.
 7. Plug one end of the printer cable into the appropriate connector on the printer. Plug the other end into the adapter reserved for the printer at the rear of the Computer.
 8. Plug the computer cable into the System I/O port at the rear of the CPL. Plug the other end of this cable into the matching adapter at the rear of the computer.
 9. Plug the power cords for the printer, monitor, and the CPL into appropriate, individual wall outlets. Refer to *Safety*.

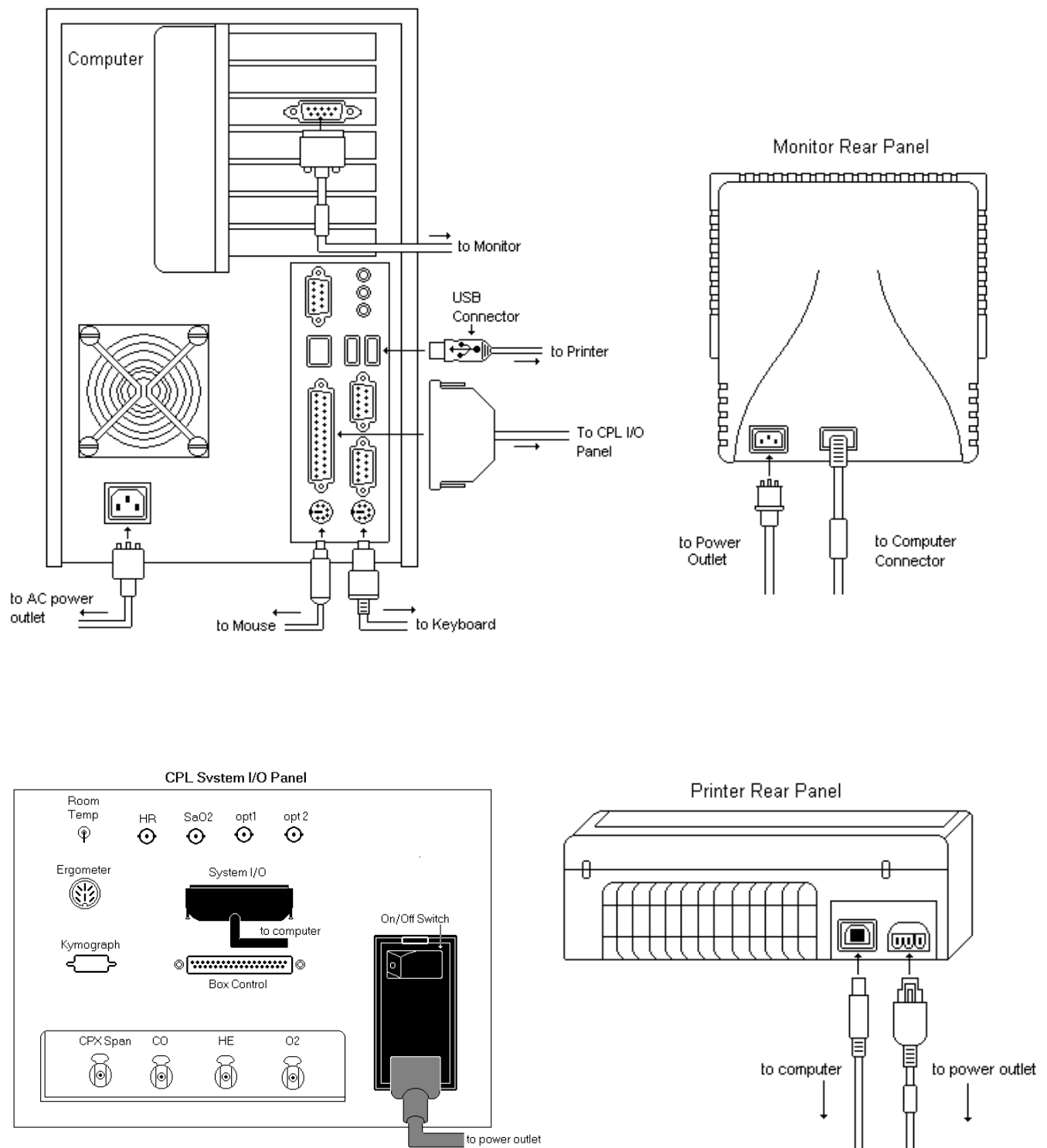


Figure 1-5. CPL Cable and Power Cord Connections

Connecting the Body Plethysmograph

If you have the Collins Body Plethysmograph (non-digital), plug one end of the Body Box cable into the cable connector at the lower rear of the Body Box. Connect the other end of this cable to *the Box Control* port on the System I/O panel at the rear of the CPL.

Preparing the Gas Tanks

1. The calibration/test gas tanks are mounted on the rear of the CPL. You will need to turn these tanks on when directed to by the test instructions. There are four gas tanks; listed below are their color-coded connectors on the lower rear panel of the CPL:

- a. DL test gas - Yellow
- b. Helium - Orange
- c. Oxygen - Blue
- d. Exercises test gas (CPX Span) - Silver

Refer to Specifications for the exact composition of each of these gasses.

NOTE:

In order to insure proper calibration of the CPL, it is mandatory that these be certified calibration gasses.

2. The components associated with the gas tanks are as follows:

Tank Stem: This is the metal stem at the top of the tank. When this stem is turned counterclockwise with a tank wrench, the full pressure of the tank is released. The regulator dial displays the full pressure of the gas coming out of the tank.

Regulator: This is the assembly that mounts on top of the tank over the valve stem. Its function is to reduce and regulate the pressure coming out of the tank, as indicated by the dial, to a preset pressure. The CPL tanks are preset at the factory at 50 psi.

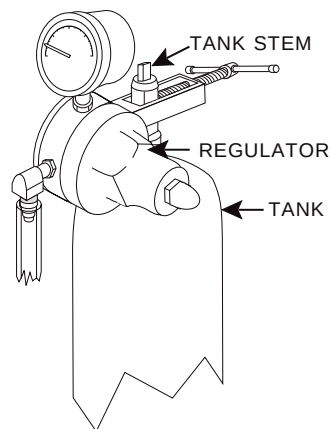


Figure 1-6. Gas Tank Components

- 3. Secure the appropriate regulator gauge on each cylinder. Place the large white regulator gauge on the He cylinder, the green gauge on the O₂ cylinder, and the red gauge on the DL cylinder. Place the remaining regulator gauge on the CPX gas tank.
- 4. Indexing pins and holes on the regulators and cylinders ensure proper regulator-cylinder attachment. Tighten the gauge to the cylinder by turning the T-handle on the regulator tankmount clockwise.
- 5. Attach the tubing leading from each regulator to its respective inlet on the lower rear panel of the CPL. Note that these inlets are color-coded to match the quick connect fittings at the end of each tubing.

6. To open the gas cylinders, turn the regulator stems counterclockwise with a tank wrench. Then, if you have a needle valve, turn it 3 or 4 times counterclockwise. To close the cylinders, turn the needle valve fully clockwise; then turn the regulator stems clockwise with a tank wrench.

NOTE:

Over-tightening the regulator stems could cause damage to the cylinders. Therefore, do not use a long-handled wrench to tighten the stems; use only the tank wrench. Recommended torque is 35-inch lbs.

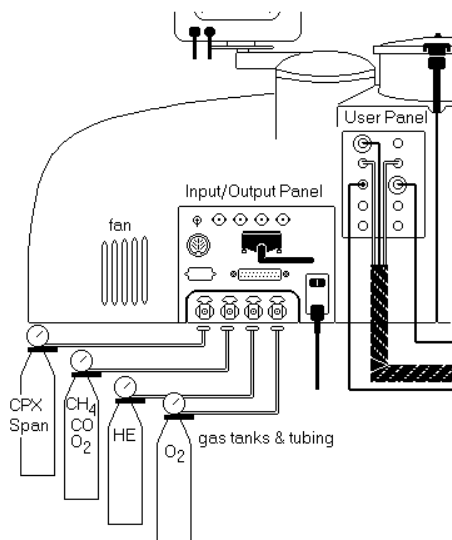


Figure 1-7. CPL Rear Panel with Gas Tanks

Preparing the Balloon Valve for Testing

Depending on the test being conducted, you may use either the Balloon Valve or the MicroTach for Pulmonary Function Testing. Preparing the Balloon Valve is described below, followed by instructions for preparing the MicroTach. Refer to Figures 1-7 and 1-8 when following the steps for the balloon valve.

1. The Balloon Valve, coupled with PLUS software, allows for automatic positioning of the spirometer bell for all pulmonary function tests, including spirometry (FVC, MVV, SVC). The option remains, however, to conduct spirometry tests without using the valve.
2. If automatic positioning is selected for spirometry, there is no need to reattach the tubing between different tests on the same patient. Tubing attachment is as described below.
3. On the side of the CPL are two breathing ports, which are part of two internal circuits leading into the spirometer bell. One port is referred to as the Common Port, as all 3 types of tests involve this circuit. The other is referred to as the Rebreathing Port, as only tests involving rebreathing (FRC and optionally, SVC and MVV) employ this circuit. Likewise, the two ports on the bottom of the Balloon Valve are referred to as the Common and Rebreathing ports.
4. Connect the two breathing tubes provided to the CPL Common port (the one with the green dot above) and to the Rebreathing port (the one with the red dot above). Attach the opposite ends of each tube to the corresponding port on the underside of the balloon valve. Note that the connections are color-coded in order to not mix up the tubing. Be sure to connect green with green and red with red.

NOTE:

The ends of the breathing tubes contain dry natural rubber. There are no latex components.

5. Attach a DC-2 filter to the patient port on the front of the Balloon Valve by inserting the reduced end of the filter into the port. The DC-2 is a low-resistance barrier filter designed for use in preventing saliva droplet contamination of pulmonary equipment, thereby preventing patient cross-contamination. The DC-2 filter may be used alone. However, if the patient has a difficult time maintaining a lip seal on the DC-2 opening, a Collins Comfort Fit® mouthpiece may be attached to the DC-2.
6. If performing spirometry tests not using the valve, simply keep the tubing attached to the common port and disconnect it from the valve. Insert a fresh disposable mouthpiece or filter into the free end of the tubing. Insert a rubber stopper into the rebreathing port.
7. Make sure that the tank of O₂ for operating the Balloon Valve is connected to the appropriate inlet on the lower rear panel of the CPL (the blue one) and that it is turned on. To do so, turn the regulator stem counterclockwise with a tank wrench. To turn the tank off, turn the regulator stem clockwise.

For more details on the O₂ tank and the other three gas tanks, refer to *Preparing the Gas Tanks*.

8. Attach the clear tubing end of the DL Sample Line to the port labeled Alveolar Sample on the CPL User Side panel, matching up the correct color-coded fittings and being sure that the appropriate filter is connected (*Replacing the Sample Lines*). Connect the free end of the Sample line to the Sample fitting on the Balloon Valve.
9. Attach the Nafion end of the Exercise sample line to the port labeled CPX Sample on the CPL Input/Output panel, matching up the correct color-coded fittings. This end of the sample tube will remain connected to the CPX Sample port always.
10. During Exercise calibration, connect the free end of the sample line to the CPX Cal fitting on the CPL, as instructed by the software. During Exercise testing, connect the free end of the sample line to the fitting on the CPX MicroTach adapter. The MicroTach requires an adapter in order to connect to the facemask or the mouthpiece used during exercise testing with the Collins CPL system.
11. The balloon valve rests in a cradle on the CPL arm and may be positioned for patient height by moving the arm. The valve may also be removed from the cradle to be hand-held. Remove it by loosening the large knob on the side of the valve.
12. To complete the test setup, attach a noseclip to the patient.
13. Refer to the testing instructions in the PLUS Manual.

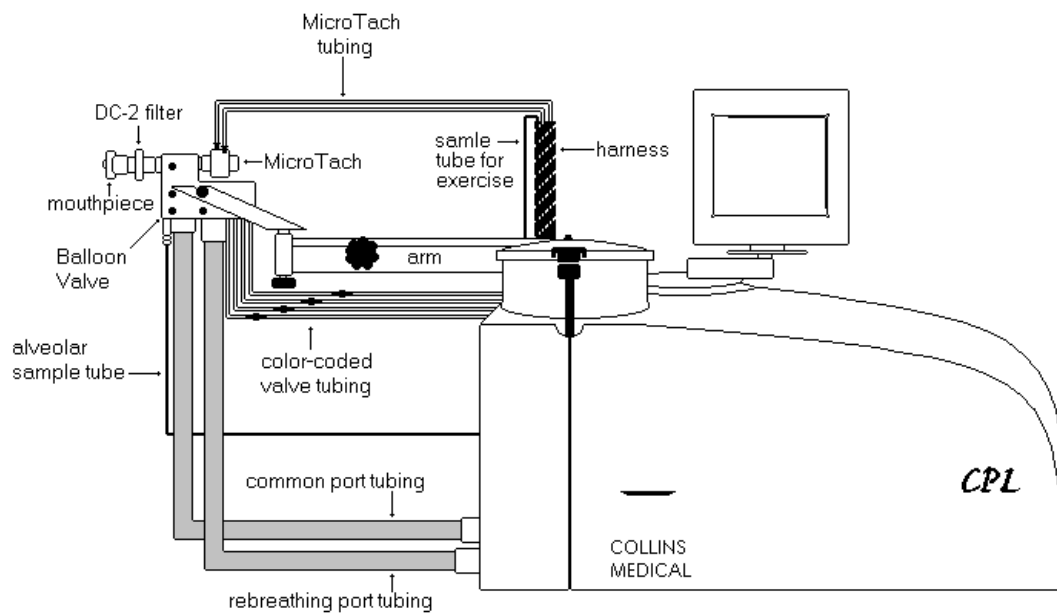


Figure 1-8. CPL Tubing Connections for Pulmonary Function Tests – Front

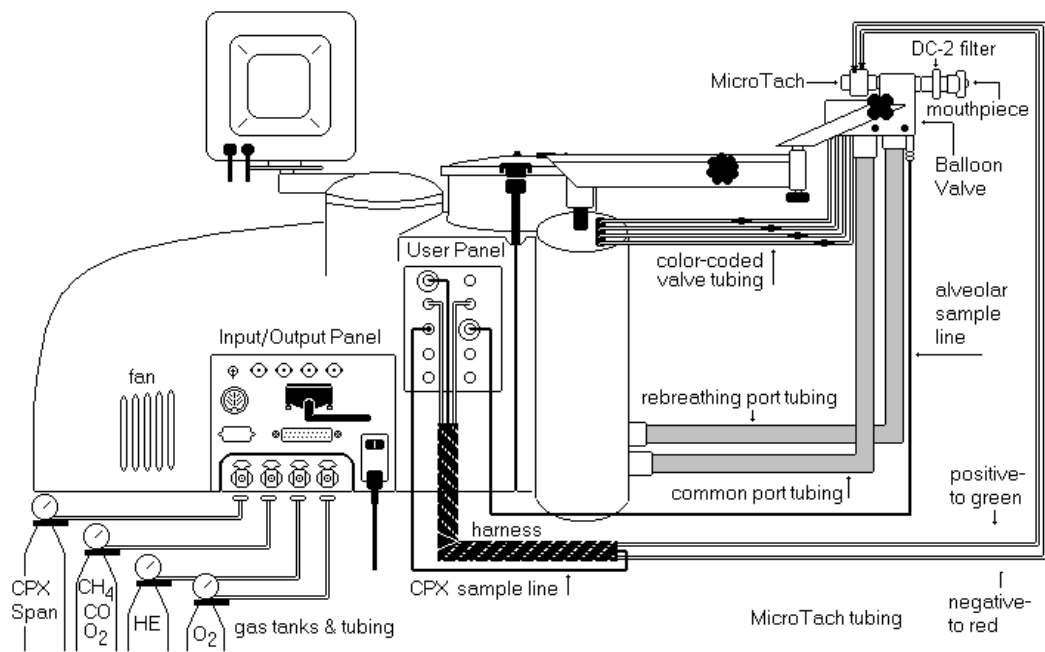


Figure 1-9. CPL Tubing Connections for Pulmonary Function Tests – Rear

Preparing the MicroTach for Testing

NOTE:

When using a new MicroTach, be sure to remove the protective endcaps from each end of the MicroTach; otherwise, there will be no flow through the unit.

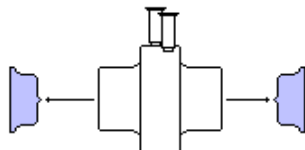


Figure 1-10. Removing the MicroTach Endcaps
-- MicroTach Part #: 003500

1. Note that two pressure tubes leading from the MicroTach have red and green Luer fittings on each end. On the MicroTach end, make sure that the green tubing is attached to the fitting that is closest to the patient (indicated by a green dot). Match the other ends with the red and green connectors (Flow + and Flow -) on the User Side panel of the CPL unit. Note that these two tubes are contained in the black harness.

NOTE:

When connecting Luer fittings, always give the fitting a $\frac{1}{2}$ turn counterclockwise before sliding it onto the connector. This will ensure that the tubing is tight.

2. Connect the Patient End (one with the green dot) of the MicroTach to the port opposite the patient port on the Balloon Valve.
3. Attach the reduced end of a DC-2 filter into the patient port on the front of the Balloon Valve. The patient will breath from the DC-2 filter. You may also attach the Collins Comfort Fit® mouthpiece to the patient end of the DC-2 filter.
4. For more detailed setup procedures, such as inserting the CO₂ absorbent cartridge, the desiccator columns, and the dry spirometer bell, etc., refer to Maintenance.
5. To complete the test setup, attach a noseclip to the patient.

Powering up the System

1. Be sure to observe the Safety Precautions, which precede the CPL Installation instructions.
2. Each system unit, that is, the CPL, monitor, printer, and computer, must be plugged into an individual isolated wall outlet. This requires that each component be powered up individually by turning on the power switch.
3. The CPL power switch is located on the rear of the system next to the power cord. To turn the power to the CPL on, turn this rocker switch to the I position. The green LED light (shaped like an eyebrow) on the front of the CPL will be illuminated, signifying that it is energized.
4. Turn on each of the other system components according to their respective documentation.
5. The monitor will display a series of system data, followed by the Windows Desktop with the available applications.
6. Adjust the monitor screen for brightness and clarity according to the monitor documentation.

Components and Controls

Following is a description of each CPL component and control for quick reference.

Analyzers

The CPL analyzers are located internally and are used to analyze the gas content of patient breath samples.

He Analyzer: Determines the amount of Helium in the patient breath sample or in the calibration gas during DSB and FRC testing.

O₂ Analyzer: This is a fuel cell-type analyzer, which measures the O₂ partial pressure in each patient breath or in the calibration gas during exercise testing. To replace, refer to *Maintenance*.

microGA Multiple Channel Analyzer: This analyzer measures the amount of CO₂, CO, and CH₄ (methane) in each patient breath or in the calibration gas during Diffusion testing.

Input-Output Panel

This panel is located on the rear of the CPL and contains the components described below:

AC Power Cord: The power cord for the CPL unit is located at the lower right rear. This cord must be plugged into a U-grounded outlet.

Analog Ports: The four analog input ports, located on the CPL Input/Output Panel at the rear of the system, are for optional devices.

Cal Gas Inlet Ports: The calibration gas from the tanks enters the CPL system via these four ports, located on the lower rear of the CPL. Each port is equipped with a color-coded, quick-disconnect or Luer fitting. To connect the calibration tanks, attach the tubes to their color-matched fittings.

Fuses: Located in a compartment above the power cord on the CPL Input/Output Panel, the fuses provide protection to the CPL electrical circuitry.

Kymograph Port: For attaching the optional kymograph.

On-Off Switch: The CPL power switch is located on the Input/Output panel, above the power cord.

System IO Port: The computer cable is connected to this port, which is located on the CPL Input/Output Panel. It is a 37-pin female D connector.

Box Control Port: If you have the Collins Body Plethysmograph, it is connected to this port. Plug one end of the Body Box cable into the cable connector at the lower rear of the Body Box. Connect the other end of this cable to the Box Control port.

Temperature Probes: The CPL may be equipped with 2 temperature probes. Both are located internally, one in the spirometer bell and the other behind the room air intake fan (labeled Room Temp). The spirometer probe allows the user to monitor the temperature of the spirometer as desired. The Room Temp probe determines the temperature corrections used in the calculations.

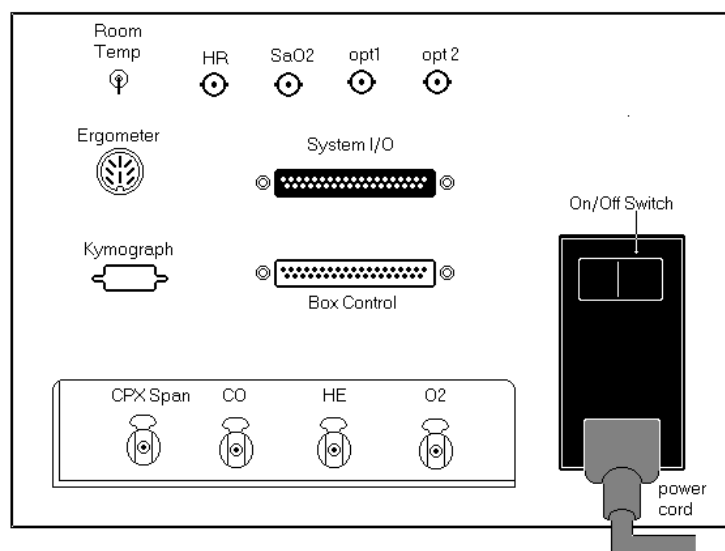


Figure 1-11. CPL Input/Output Panel

User Side Components

This panel is located on an angle at the rear of the CPL unit.

Alveolar Sample Port: The gas sample produced during DL testing passes through this port en route from the DL sample line to the analyzers inside the CPL.

Aux 1 Port: This input connector is reserved for future use

Compliance Balloon Port: For connecting the tubing leading from the esophageal balloon in the compliance test.

Compliance Valve Port: For connecting the tubing leading from the valve in the compliance test.

CPX Sample Port: The gas sample produced during CPX calibration or testing passes through this port en route from the CPX sample line to the CO₂ and O₂ analyzers inside the CPL. From this point, it is discharged by the vacuum pump to room air.

CPX Cal Port: During CPX calibration, the Sample Line is removed from the MicroTach and attached to the CPX port. Calibration gas is pushed by the tanks through the system, vented, and suctioned through the CPX Sample port. The cal gas from this point on follows the same path as the patient breath: through the sample tube to the CPX Sample Port, through the CO₂ and O₂ analyzers, after which it is discharged by the vacuum pump to room air.

Dosimeter Port: For connecting the dosimeter during post-drug FVC testing.

Mouth Pressure Port: For measuring mouth pressure during lung compliance tests, MIPS/MEPS tests, and post-drug tests in which the dosimeter is used.

Flow+ and Flow- Ports: These are the MicroTach pressure inlet ports. The MicroTach tubing is attached to these green (positive) and the red (negative) ports.

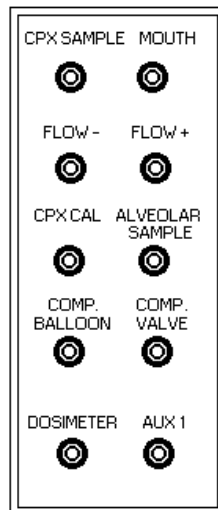


Figure 1-12. CPL Right Rear Panel (User Side)

Miscellaneous Components

Balloon Valve: Located at the end of the articulated arm on the CPL. The patient breathes through this valve, which automates a variety of pulmonary function test procedures. Several small balloons expand and contract to open and close various apertures in the valve, thereby activating specified areas of the CPL.

Cal Syringe: This device is used to calibrate the MicroTach and the spirometer.

CO₂ Absorbent Cartridge: This canister contains soda lime for the purpose of scrubbing excess CO₂ produced by the patient during tests involving rebreathing through the circuit.

Desiccator Columns: There are two disposable desiccator columns, described below.

H₂O Absorbent Column: This column contains a desiccant known as Drierite, for moisture absorption in the FRC helium analyzer circuit. The column should be changed when the blue granules turn pink. It is located outside the system on the rear of the arm support panel.

Desiccator Column for Analyzer Reference Cell: this column, which is shorter than the other one, contains Drierite for the purpose of absorbing moisture from the reference cell of the helium and CO analyzers. It should be changed when the blue granules turn pink. This column is located inside the CPL system between the spirometer and the electronics compartment.

Harness: This is the long black spiral casing which contains the green and red MicroTach tubing, as well as the CPX sample line.

MicroTach: The pneumotach used in the system, the Collins MicroTach, allows pneumotach-based spirometry with the CPL. The MicroTach measures flow directly and integrates flow to arrive at a volume measurement.

Reusable Mouthpiece: This is used to connect the patient comfortably and securely to the MicroTach or the Balloon valve. A clean mouthpiece must be used for each patient.

When used for spirometry with the balloon valve, the mouthpiece is attached to the Patient Port on the valve, preferably with a DC-2 filter between the mouthpiece and the valve.

When used for spirometry with the MicroTach, the MicroTach is attached to the port opposite the patient port on the Balloon Valve and the mouthpiece is attached to the patient port on the front of the Balloon Valve. It is preferable to have a DC-2 filter between the mouthpiece and the patient port.

Alveolar Sample Line: This is a length of thin Nafion tubing which transports patient breath from the balloon valve to the analyzer circuit in microGA DL testing. One end of the sample line is always connected to the Alveolar Sample fitting on the right rear panel of the CPL. The free end of the Sample line is connected to the Sample fitting on the balloon valve.

NOTE:

The sample line tubing is of a specified length and must not be trimmed back if worn or damaged. Instead, replace the tube. The sample line is equipped with a filter at the sample input ends, which must be changed periodically. Refer to *Maintenance* for details.

Spirometer: This is a Stead-Wells, dry-seal, 10-liter spirometer for measuring flows and volumes in pulmonary function testing

SECTION TWO -- PERIODIC MAINTENANCE

Warning – Before Proceeding

WARNING:

Before performing any maintenance procedures, make sure the power to the CPL system is off and that the power cord is disconnected.

Customer Support

The CPL has no user internal serviceable parts. Therefore, for issues not covered in Maintenance, or if you are having problems with your system, contact Collins Medical personnel at:

Collins Medical, Inc,
220 Wood Road
Braintree, MA 02184

Phone 800-635-3200

or

781-843-0610 and ask for the Customer Support Services Department

FAX: 781-843-4024

...or your local distributor

Routine Cleaning of the CPL Covers and External Components

Frequency: Annually

1. Turn off the power to the CPL by moving the rocker switch at the rear of the CPL to the O position.
2. Remove the power cord from the inlet connector.
3. All external components of the system, including the system covers, used within the patient environment, may be disinfected by wiping the surfaces with a 70% isopropyl alcohol solution. DO NOT get the solution on or near the AC power inlet connector.
4. Plug in the power cord.
5. Turn power to the CPL module on by moving the rocker switch to the I position.
6. Refer to *Installation* to verify correct system start-up.
7. If your system does not start up correctly, contact Collins Customer Support Services at the addresses or telephone numbers listed above.

Removing CPL Covers

1. Some of the procedures described below require removal of the CPL covers. There are two covers that may be removed, the one surrounding the front of the spirometer, called the Access Cover, and the remaining one, called the Main Cover. The cover holding the arm base is anchored to the CPL body.
2. To make the cover lighter to lift, you may first remove the Monitor base and arm simply by lifting it off.
3. The Access Cover must be removed in order to remove the Main Cover. To remove the Access Cover, simply lift it up.
4. At the lower right of the spirometer, you will see a screw on the main cover. Use a Phillips head screwdriver to loosen this screw.
5. At the rear of the CPL, to the right of the System I/O panel, there is another Phillips head screw to be loosened.
6. To the right of the User Panel is a knob which may be loosened manually (some models have a stubby flathead screw which must be removed).
7. After loosening the three screws, if you are still facing the rear of the unit (facing the I/O panel), take the main cover and slide it about $\frac{1}{2}$ inch to the left, then lift it up to remove it. Since the Main panel is intended to rest securely on the CPL, it may take some effort to remove the panel.

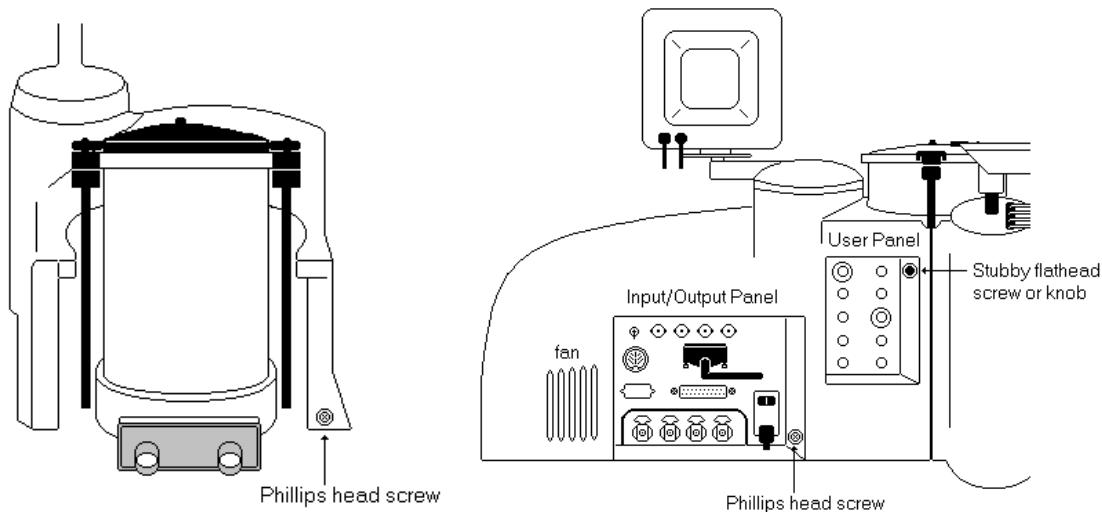


Figure 2-1. Locations of the Three Screws for the Main Cover

Replacing Fuses

1. Shut off the CPL power. Remove the power cord.
2. Pry open the power outlet cover using a device such as a small screwdriver. The cover will drop down.
3. Pry out the two fuse holders. If the fuse has blown, the fine wire element on the inside will be separated. Remove the blown fuse(s) from its cradle in the holder.
4. Replace the blown fuse(s) with metric 3.15-amp fuses. When replacing the fuse holder, make sure the arrows on the holder point in the same direction as the arrows on the inside covers.

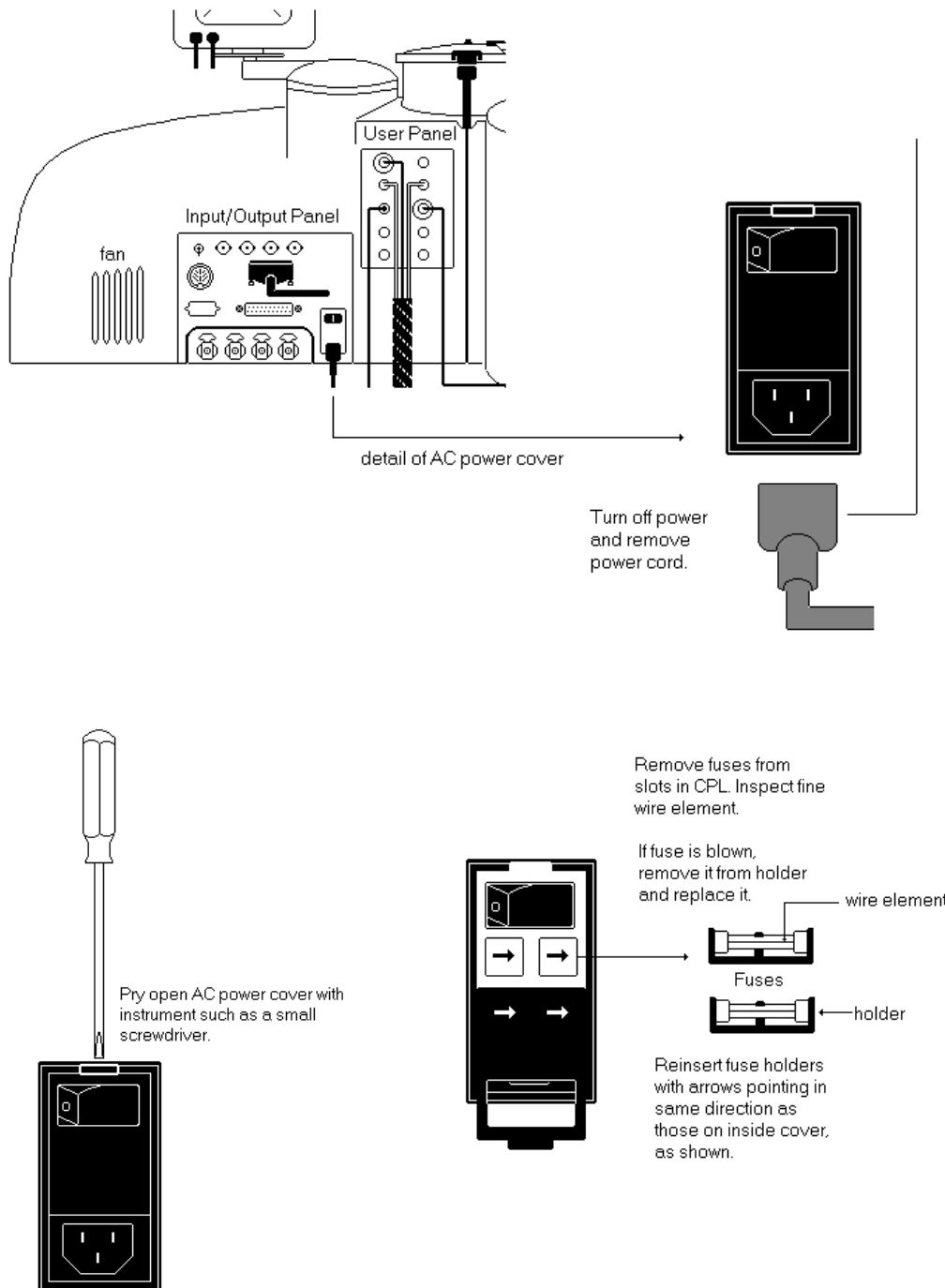


Figure 2-2. Replacing the Fuses

Replacing the CO₂ Absorbent Cartridge

1. The CO₂ Absorbent Granules (Soda Lime) come in a disposable cartridge, which is inserted into the CPL in a manner similar to a vacuum cleaner bag. The cartridge should be changed every 10-15 lung volume tests or approximately one hour of patient testing time.
2. The front panel of the spirometer base, which contains the two breathing ports, is easily removed to access the CO₂ absorbent cartridge. Simply raise the lever on each side of the panel and pull it away from the spirometer body.
3. Inside you will see the cartridge. Grasp the pull-tab and remove the old cartridge. Insert the new cartridge in the same orientation as the old one, with the blue port to your right. Make sure the blue foam rubber protrudes slightly from the opening in order to form a tight seal when you replace the front panel.
4. To replace the front panel, line up the holes on the inside of the panel with the pins on the base. Slide the cover onto the pins. Push down both levers over the handles on each side of the panel so that they secure the panel, making a tight seal.

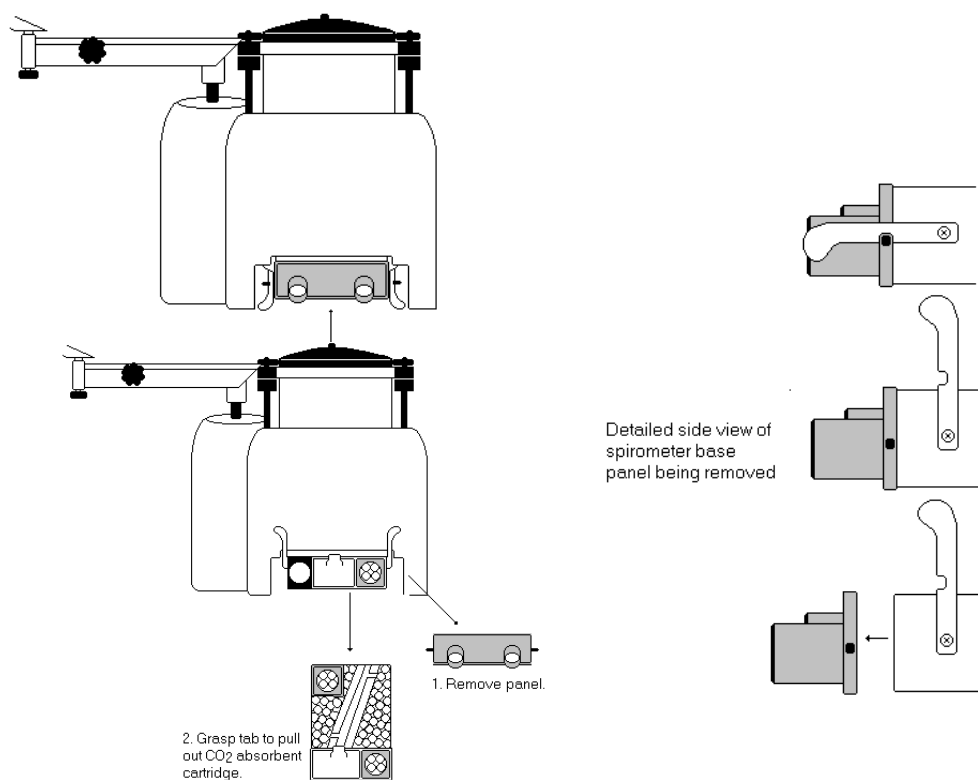


Figure 2-3. Replacing the CO₂ Absorbent Cartridge

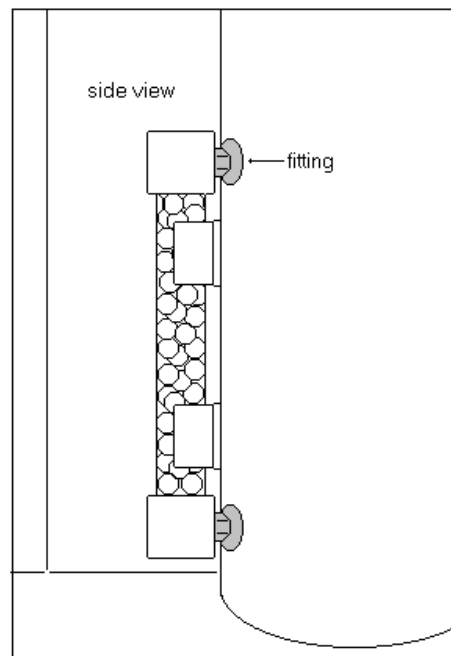
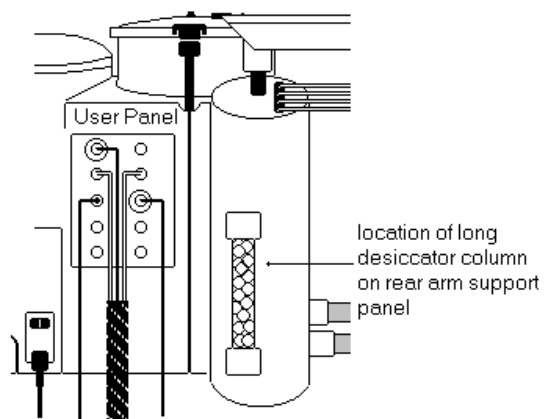
Replacing the Desiccator Columns

1. There are two disposable desiccator columns:

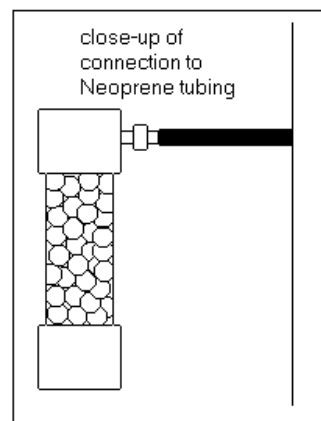
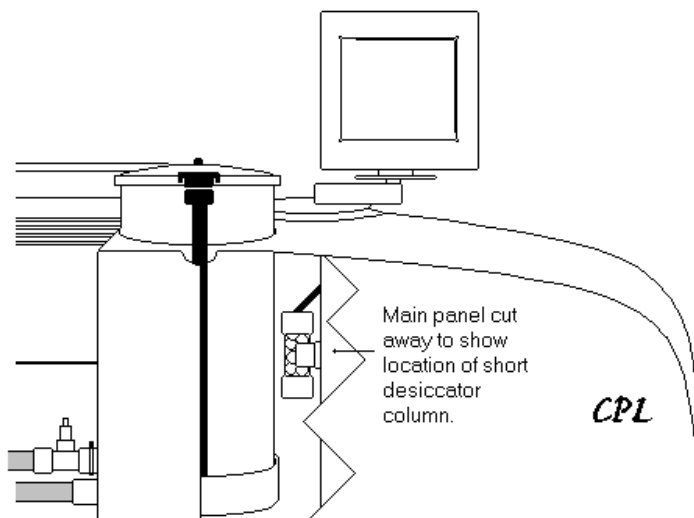
H₂O Absorbent: This column contains a desiccant known as Drierite, for moisture absorption in the FRC helium analyzer circuit. The column should be changed when the blue granules turn pink. It is located outside the system on the rear of the arm support panel.

Desiccator Column for Analyzer Reference Cell: This column, which is shorter than the other one, contains Drierite for the purpose of absorbing moisture from the reference cell of the helium and CO analyzers. It should be changed when the blue granules turn pink. This column is located inside the CPL system between the spirometer and the electronics compartment.

2. To replace the long desiccator column, remove the old one from the metal fittings at the top and bottom sides by simply pulling it out from the fittings. To replace the short column, remove the CPL main cover (the one with the CPL logo on it); then simply remove the column from the top side fitting.
3. Remove each of the new columns from its foil pouch. For the long column, puncture the two small holes on the top and bottom side with a small, sharp instrument, such as a paper clip. Be sure to break through the thin seal made of Kraton G. For the short column, puncture just the hole at the top side.
4. Gently push each column onto the metal fittings in the same manner that you removed the old one. That is, for the long column, attach the top and bottom to the fittings at the top and bottom. For the short column, attach just the top to the fitting at the end of the black tubing. Make sure to replace the columns in their same positions, as described above.
5. Any time the CPL is not going to be used for an extended period (2-3 days), the CO₂ absorbent canister and the desiccant columns should be removed.



Long Desiccator Column



Short Desiccator Column

Figure 2-4. CPL Desiccator Columns

Replacing the Sample Lines and Filters

1. The Nafion/Teflon Sample Lines should be replaced every four months. To change the sample lines, first disconnect them from the Alveolar Sample and the CPX Sample (if you have the Exercise system) ports on the CPL by turning the Luer fitting counterclockwise.
2. Replace the Nafion/Teflon lines. Connect the Nafion end of each sample line to its respective Sample port on the CPL user panel by turning the Luer fitting clockwise. In the same manner, connect the Teflon end of the CPX line to the CPX cal port on the user panel or to the Patient Breath Outlet port on the MicroTach adapter. Attach the Alveolar line to the Sample Fitting on the balloon valve.
3. Each sample line is equipped with a filter at the sample-input end (the end connected to the CPL). The Nafion Sample Lines should be replaced every four months. The filters should be replaced once a year. To replace the filter, simply unscrew the holder, drop in another filter, and reattach it.

NOTE:

The sample lines are not interchangeable. The longer of the two is for Exercise testing. The shorter of the two is for Diffusion Testing.

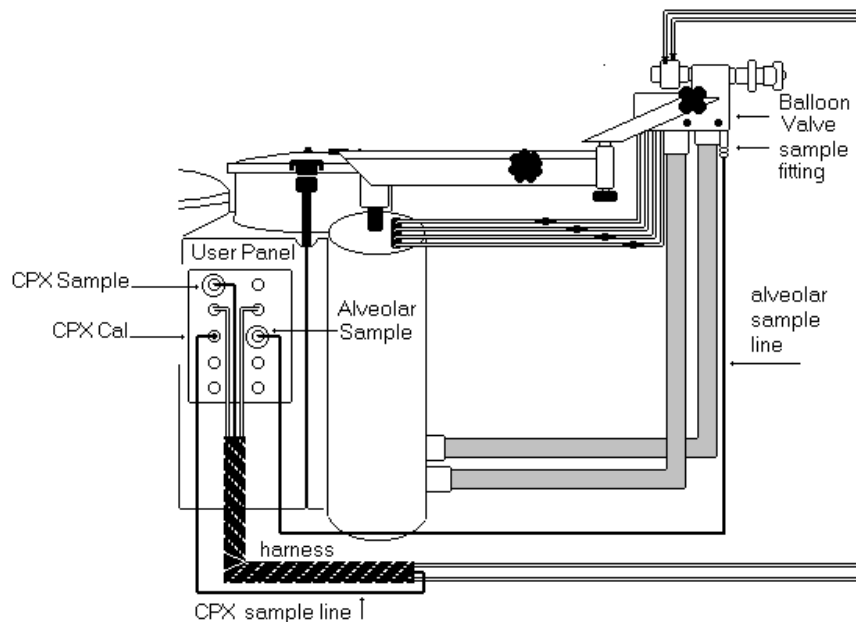


Figure 2-5. Sample Line Connections

Replacing the O₂ Analyzer

1. To access the O₂ analyzer, first remove the covers of the CPL. On the right of the electronics unit (the narrowest end of the CPL), you will see a small panel. Unscrew this panel $\frac{3}{4}$ of a turn and open the O₂ analyzer drawer. You will see the analyzer, a cylindrically shaped object, resting in its cradle.
2. Remove the ribbon cable, the Luer fitting and the small tubing from the analyzer.
3. Replace the analyzer and reattach the cable, Luer fitting and small tubing.
4. Return the analyzer to its cradle and close the panel. Tighten the screw and replace the cover of the CPL.

NOTE:

The analyzers must be open to room air for 24 hours prior to installation. Analyzer life is approximately 6 months.

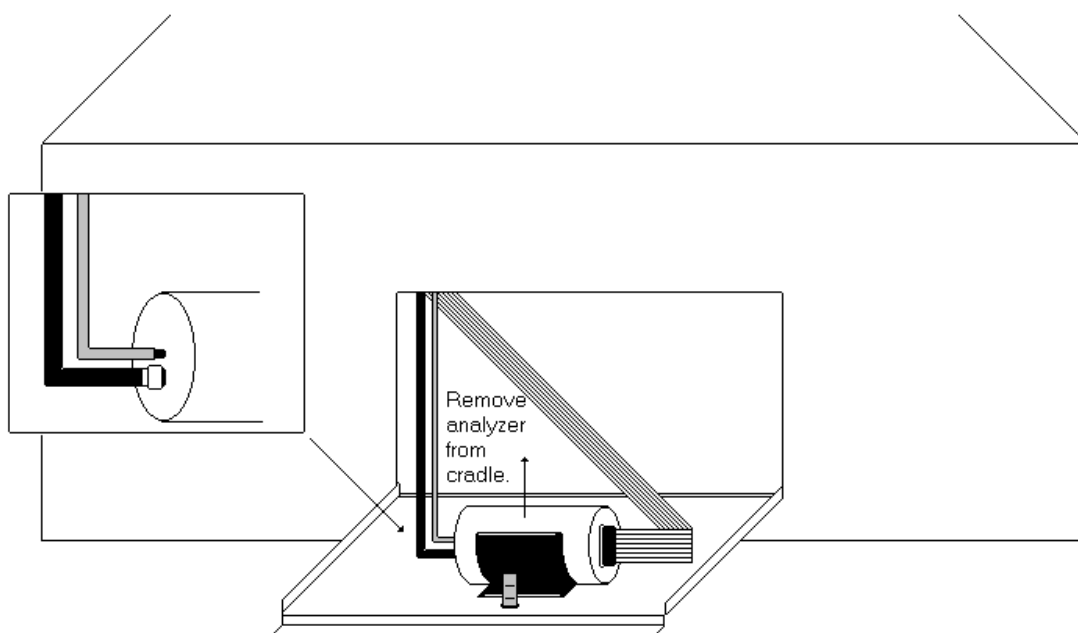


Figure 2-6. Connections on the O₂ Analyzer

Replacing the Balloon Cuffs in the Valve

1. A leak in the system when using the balloon valve could indicate a leak in the valve, most likely, a leak in one of the balloons. If a balloon cuff is damaged, it must be replaced.
2. Following is a drawing of the balloon core assembly to refer to when conducting the replacement procedure.

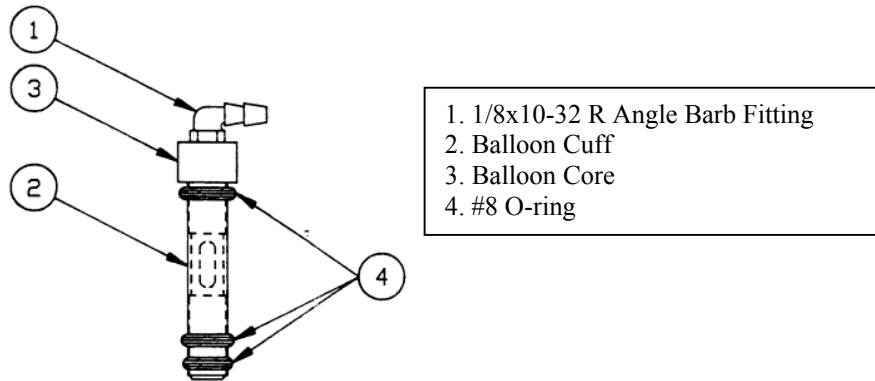


Figure 2-7. Replacing the Balloon Cuffs

3. Following are the items needed for replacing the Balloon cuffs:

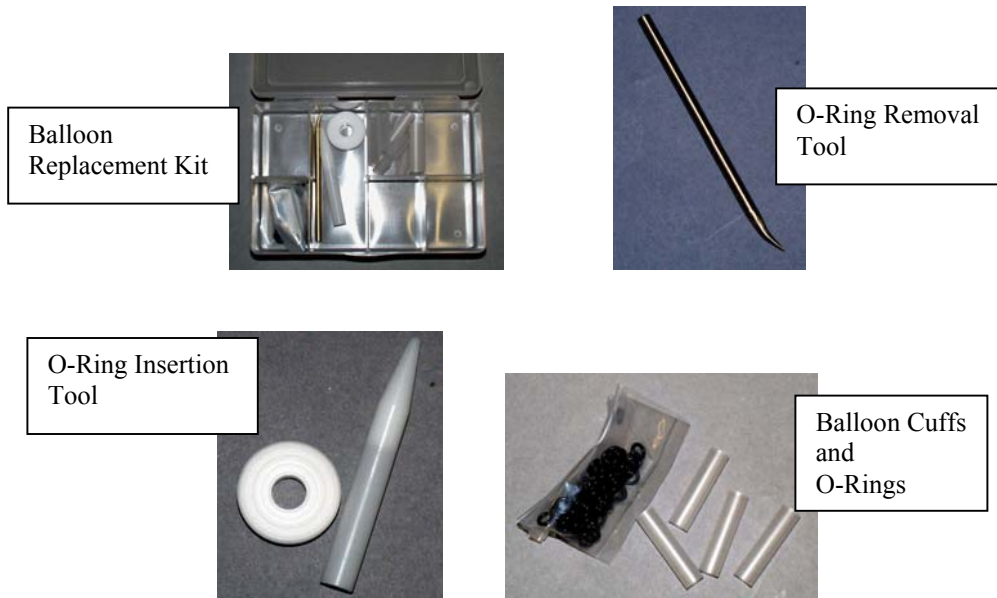


Figure 2-8. Items Needed for Replacing the Balloon Cuffs

4. Depressurize the valve by turning off the O₂ gas tank.
5. Remove the valve from the CPL. To remove the white cover, unscrew the large black knob and the black retainer nut.

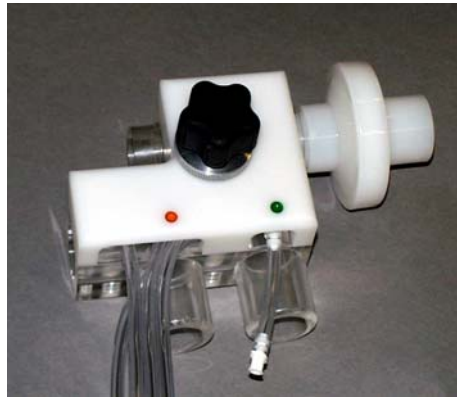


Figure 2-9. Location of Black Knob for Removing the Valve Cover

6. Remove the white cover from the valve to expose the balloon core assemblies.

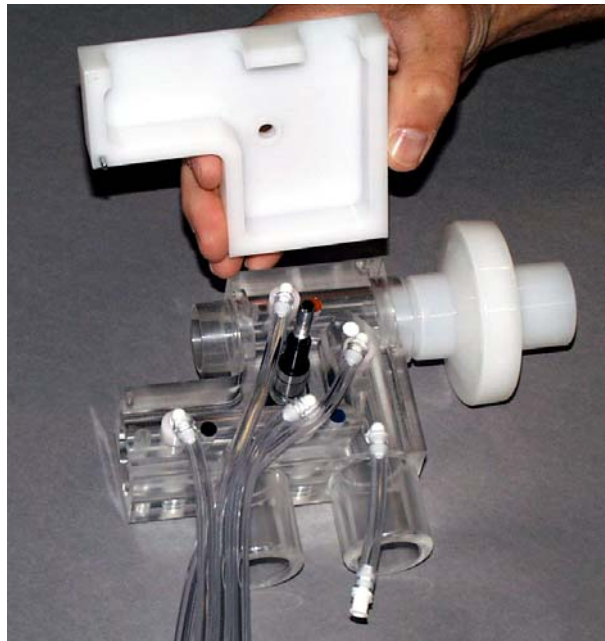


Figure 2-10. Removing the Valve Cover

7. Remove the balloon core assembly from the valve by pushing in the plain side of the core (side opposite the tubing) and sliding it out.



Figure 2-11. Sliding the Balloon Core Assembly from the Valve

8. The balloon "cuff" is secured to the core assembly by three black O-rings. The O-rings and the balloon cuff will be discarded once removed. ***Do not reuse O-rings.***

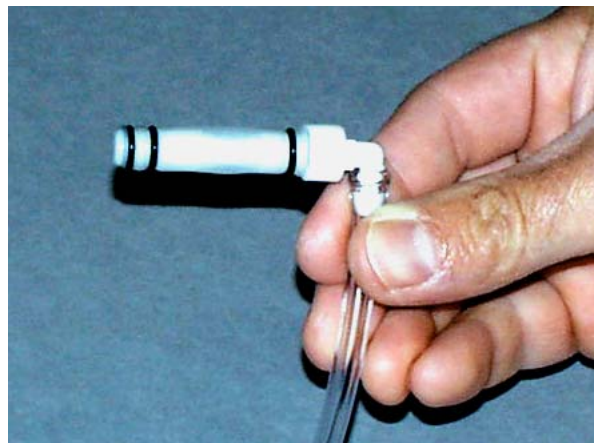
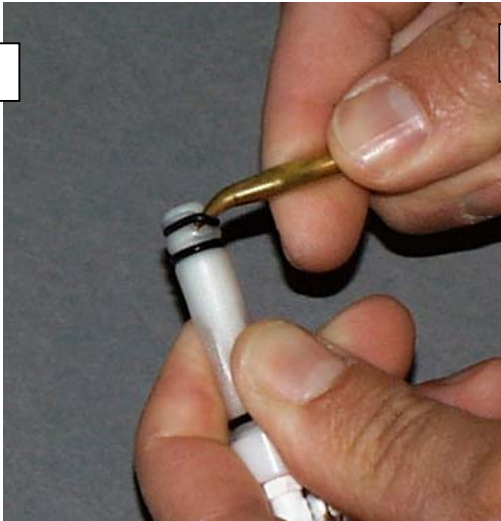


Figure 2-12. Location of O-Rings on the Balloon Cuffs

9. Using the *O-ring Removal Tool* provided, remove each O-ring. Hook the tool under each O-ring and pull it off. Once all O-rings have been removed, remove the balloon cuff from core assembly.

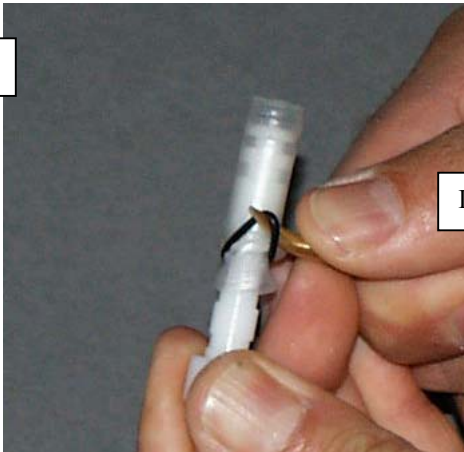
A



B



C



D

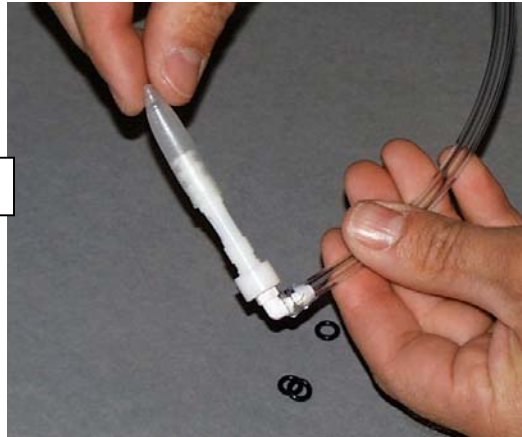


Figure 2-13. Removing the O-Rings

10. Install the new balloon cuff on the core assembly, *all the way to the shoulder*.



Figure 2-14. Installing the New Balloon Cuff on the Core Assembly

11. Install the O-rings using the *O-ring Insertion Tool* provided. First apply a light film of Super Lube® to the outside of the tool bar. Then start the O-ring up the tapered end of the bar. Using the tool collar, finish sliding the O-ring to the opposite end of the bar.

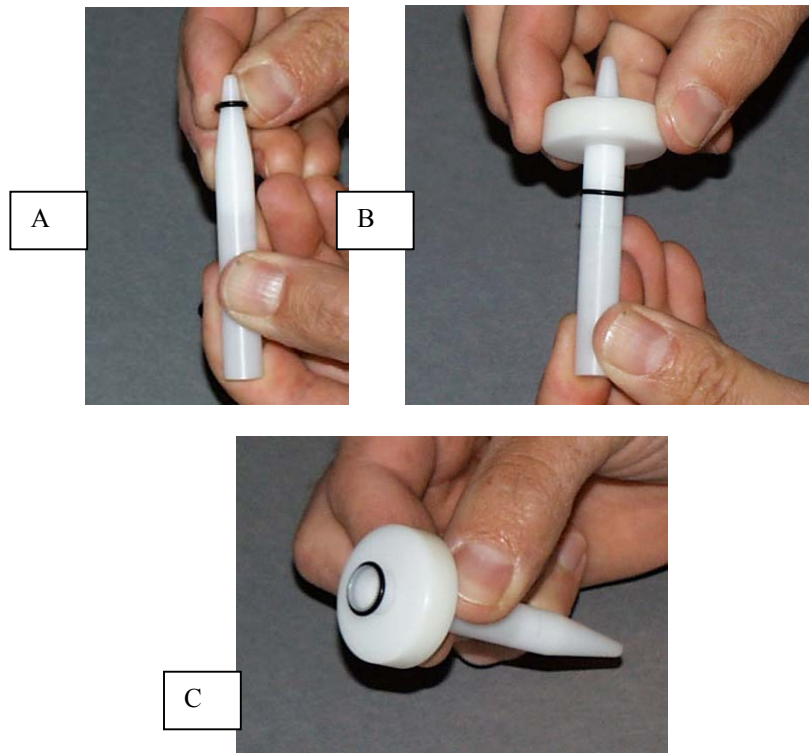


Figure 2-15. Sliding an O-Ring onto the Insertion Tool Bar

12. Slide the O-ring Insertion Tool over the balloon and core assembly. Line up the O-ring with the very beginning of the 3rd notch on the core assembly and slide the O-ring onto the notch to secure the balloon to the core.

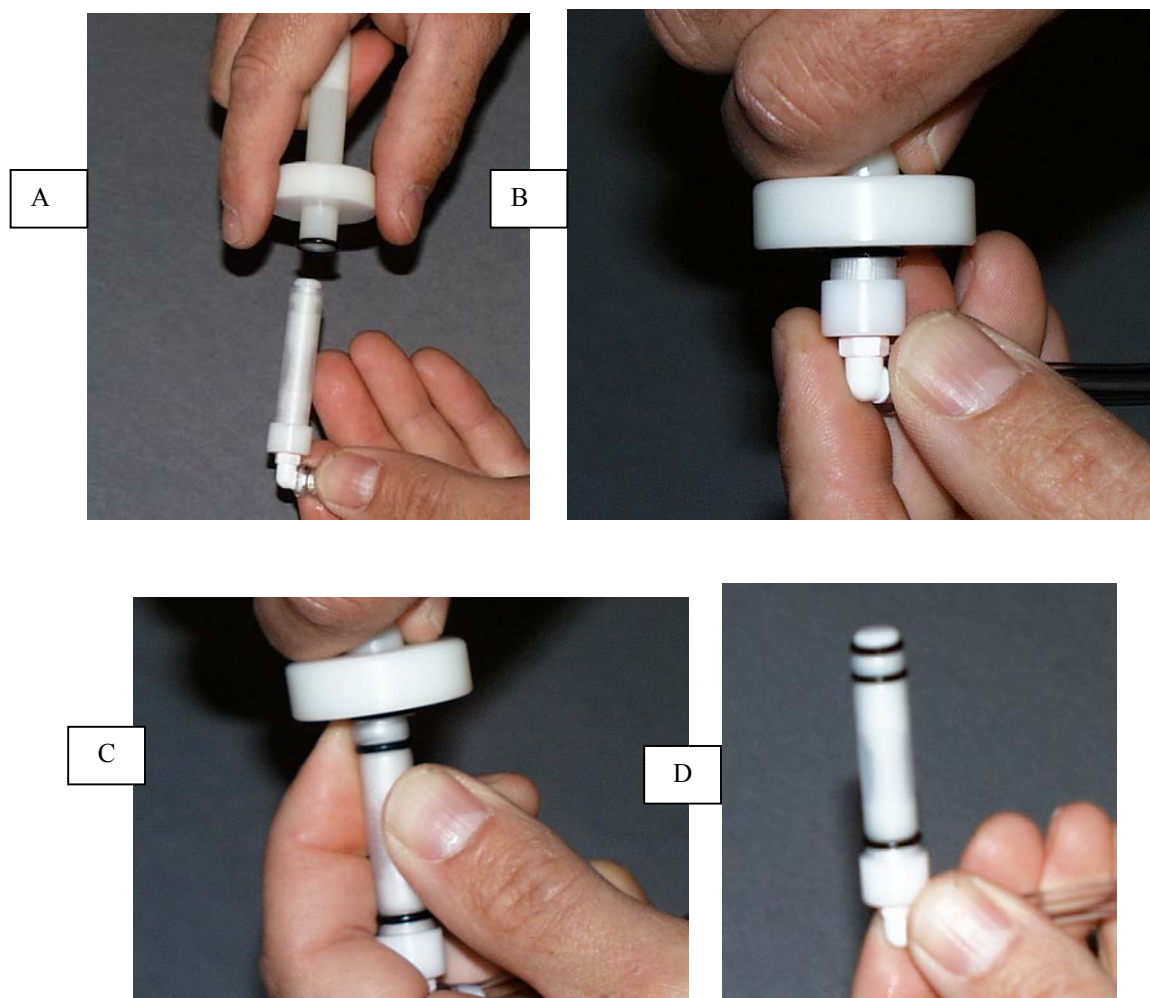


Figure 2-16. Installing the New O-Rings to Secure the Balloon to the Core Assembly

NOTE:

The O-ring Insertion Tool will not fit over installed O-rings. Work from farthest to closest.

13. Repeat the previous step for each O-ring.
14. Once all O-rings have been installed, apply a light film of Super Lube® to the outside of each O-ring and install the core assembly in the valve.
15. Before inserting each balloon, make sure that the attached tubing is pointing in the direction that it will go when the cover is replaced, that is, down through the cover slot. This is to avoid having to twist the balloons once they are seated.
16. Make sure that you do not scrape the balloon against the edge of the hole as you insert it, as this could weaken the material.
17. Insert the balloon all the way in the hole so that none of the black O-ring is showing outside the valve. If it does not go in all the way at first, keep pushing it until it does.

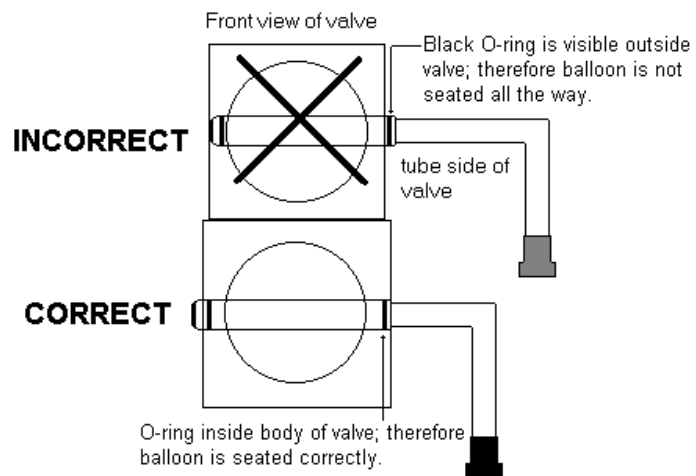


Figure 2-17. Proper Seating of Balloon Cores in Valve

CAUTION:
Never twist the balloons!

Cleaning the Balloon Valve

1. To clean the valve, first depressurize the valve by turning off the O₂ gas tank. Remove all mouthpieces and breathing tubes from it. Remove the valve itself from the CPL arm by loosening the knob and lifting it out of the arm slots. Disconnect the Alveolar Sample tube from its longer tube by twisting and undoing the white connector.

Optionally, you may disconnect each of the balloon tubes from the long clear tubes leading to the inside of the CPL. See the Note later on in this topic.

2. Invert the valve (with the tubes up) and immerse it in the disinfectant solution as indicated under the *Disinfection Procedure* further on in this section. You may immerse the whole valve body, cover and tubing, but not the fittings on the end of the tubing. This is so that water will not get into the balloons. The valve cover should hold the tubing ends upright so that it makes it easy to submerge the valve without getting the fittings wet.

NOTE:

You may simply leave the tubing connected to the longer tubing and invert the valve into the solution. If you have left the balloon tubing connected, you will not have to worry about water getting into the tubing via the fittings.

3. Soak the valve in the solution for the length of time recommended in the manufacturer's instructions. When you have completed the process, rinse the valve thoroughly according to the manufacturer's advice, again making sure to not get the tube fittings wet. Allow the whole valve to dry completely before reusing.
4. Repressurize the valve by turning on the O₂ tank.

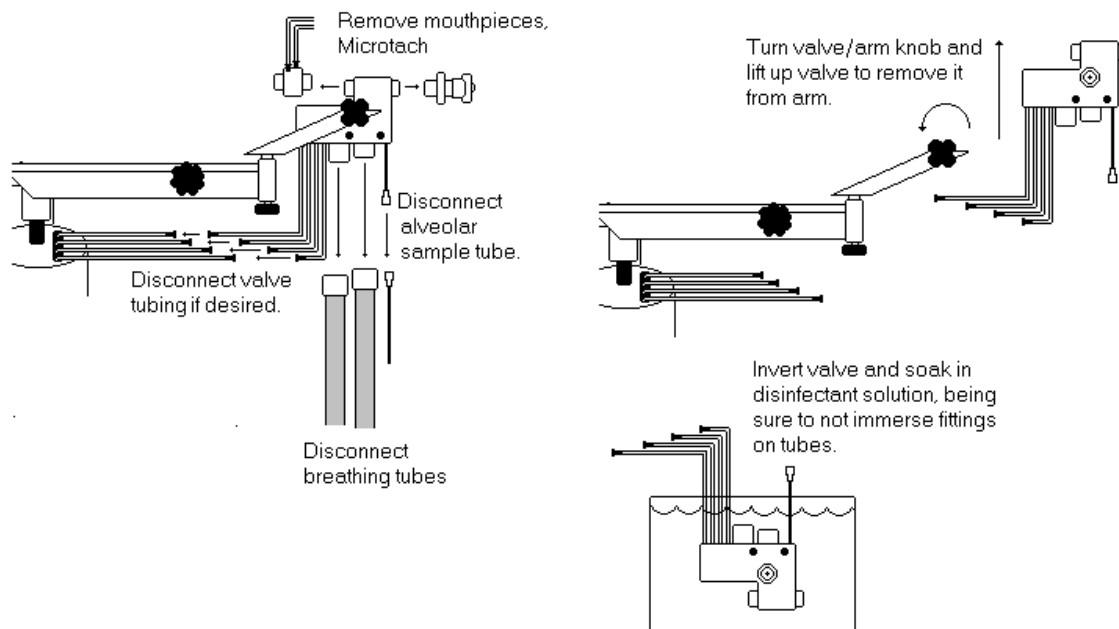


Figure 2-18. Submerging the Balloon Valve (except for tube fittings) for Cleaning

Disinfection Procedure for Mouthpieces, Connectors, Couplers and Breathing Tubes

1. Following is a recommended procedure for disinfecting reusable mouthpieces, couplers/connectors and breathing tubes.

NOTE:

The following instructions involve the use of the disinfectant Cidex®. Only trained staff may use Cidex®. Wear gloves, goggles and an apron or gown. Avoid skin contact. The solution is caustic and can cause skin irritation.

2. Activate solution - solution turns green when activated.
3. Solution must be marked with the activation date and expiration date. Solution expires 14 days after activation.
4. Wash items thoroughly in detergent and water, then rinse prior to immersion in Cidex®.
5. Immerse in Cidex® for 20 minutes.
6. Remove from Cidex® using aseptic technique and rinse thoroughly with sterile water.
 - Flush interior aspects vigorously with sterile water.
 - Insertion tubes and channels must be thoroughly dried.
7. Discard Cidex® only after it has been neutralized.

Reference: Disinfection Instructions from *John Hopkins Cleaning and Disinfection* instructions at the following Website:

http://hopkins-heic.org/prevention/clean_dis.html

Cidex® Activated Dialdehyde Solution is a product of Advanced Sterilization Products.

Disassembling the Breathing Circuit for Cleaning

NOTE:

Refer to your hospital hygiene or infection control board for their guidelines on cleaning such medical equipment and/or accessories as are described in this manual. Other sources of information on cleaning are both the AARC and ATS clinical practice guidelines. Refer to the References at the end of this section.

1. The entire breathing circuit may be disassembled and removed from the CPL unit for cleaning. Use the cleaning method of your choice. As with all sanitation procedures, the hospital infection and control committee should be the final arbiter for approval of sanitation procedures, in order that they meet with their specific needs and requirements. However, do not autoclave any of the parts.

Disassembling the Spirometer and Motor Blower Housing

NOTE:

Disassembly of the breathing circuit in its entirety is described below. However, for certain purposes it may not be necessary to disassemble the circuit to this degree. For example, if you only wish to clean the spirometer bell, it will not be necessary to remove the entire spirometer body from the base. Disassemble the circuit to the degree you find necessary. However, be sure to disconnect the necessary cables or tubing for whatever procedure you are conducting.

1. To access the spirometer body and the user-serviceable portions of the CPL, first disconnect the CPL from the AC outlet. Then remove the covers from the CPL as described at the beginning of this section.
2. Disconnect the breathing tubes from the front of the spirometer. As described *under Changing the CO₂ Absorbent Cartridge*, the front panel of the spirometer base may also be removed.
3. At the rear of the spirometer base is a cutout for the tubing that leads from inside the spirometer to the inside control panel. Note that this panel contains the tubing and cable connections for both the valve and the spirometer. Disconnect just the spirometer cables and tubing from this panel.
 - a. Disconnect the black potentiometer cable by turning the lock and pulling it from the connector.
 - b. Disconnect the thermistor probe from its white plastic connector behind the spirometer by squeezing the sides of the connector and pulling.
 - c. Do the same for the motor blower cable.
 - d. Disconnect the remaining 4 black tubes from their quick-release fittings on the panel. Do so by turning the fitting slightly counterclockwise and then pulling it out. The four fittings are labeled:

Bell
Blower
He Out
He In

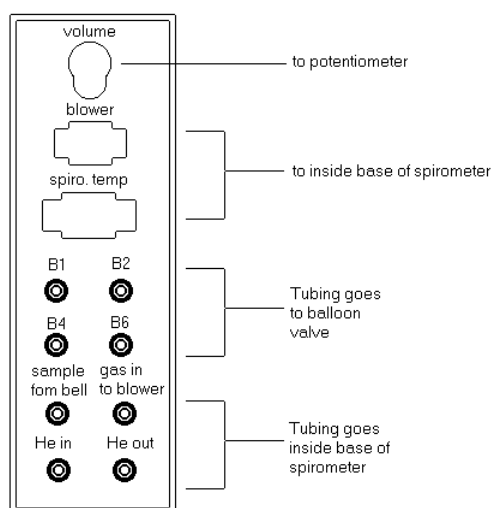


Figure 2-19. Disconnecting the Spirometer Tubing and Cables from the Inside Control Panel

4. Remove the bell from the spirometer. To do so, you must release the bell tabs at the top of the bell from the potentiometer on one side and the guide rod on the other.
5. Push the bell tabs in opposite directions with each hand until the knobs on the potentiometer and the guide rod pop out of the slots on the handles.

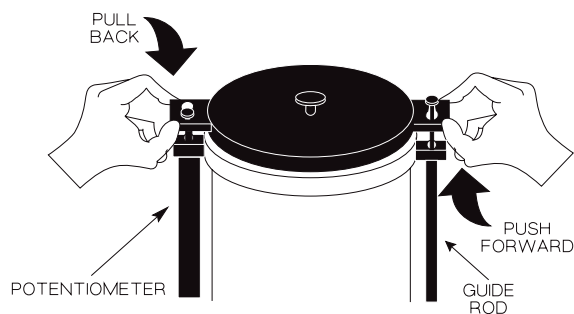


Figure 2-20. Releasing the Potentiometer and Guide Rod from the Bell

6. To remove the bell, raise it all the way by the knob at the top. Then reach into the bottom of the envelope and grasp the plastic ring at the base of the envelope. This will allow you to completely remove the bell and attached envelope.

NOTE:

Sharp rings or long fingernails could puncture the seal. Also, be careful not to squeeze the plastic bell.

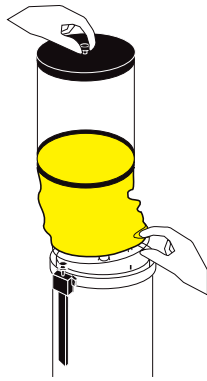


Figure 2-21. Removing the Dry-Seal Ring from the Spirometer Body

7. Remove the orange band from the inside body of the spirometer. This band should be lubricated about once a week in order to keep it flexible.

WARNING:

Do NOT use a silicone-based lubricant to lubricate the orange band, as this will prevent the band from sealing the spirometer. Be sure to use only the Collins-supplied lubricant for this purpose.

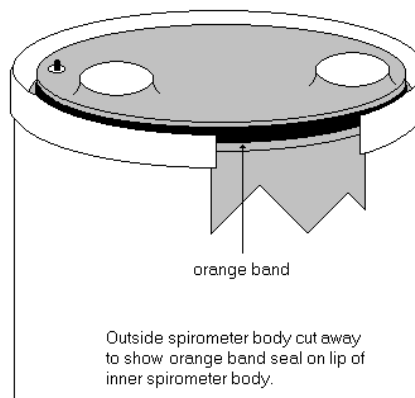


Figure 2-22. Orange Band on Inside Body of Spirometer

8. Now remove the guide rod and potentiometer. Locate the small Allen wrench that comes with your system. Loosen the two small screws on either side of the guide rod shaft. Then lift the shaft up and away from the spirometer body.

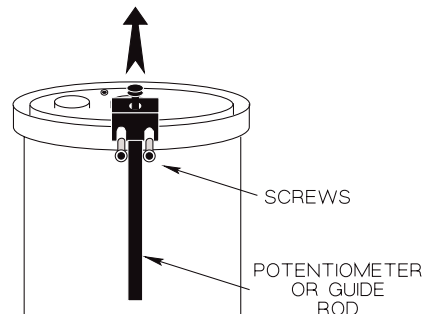


Figure 2-23. Lifting Guide Rod or Potentiometer Shaft Clear of Spirometer Body

9. Loosen the screws on either side of the potentiometer in the same manner. Then lift the potentiometer up and away from the spirometer in the same manner you did the guide rod shaft.

10. Locate the small feet at the bottom of the spirometer body. Using a screwdriver, carefully pry the body of the spirometer from the base at this location. Then lift the spirometer body away from the CPL.
11. Looking into the bottom of the spirometer, you will see the two breathing tubes attached to the two ports at the top of the spirometer and at the base. Remove the spirometer tubing from both locations.
12. Remove the thermistor probe from its fitting at the top of the spirometer.
13. You will now be able to remove the spirometer body completely from the base.
14. Once the spirometer is removed, you will also see the motor blower housing with its connected tubing. Disconnect all lines from the Luer fittings on the motor blower housing. If the blower is equipped with a bracket, remove this as well.
15. The spirometer bell, body, tubes and port may now all be cleaned according to the preferred method.
16. Pull out the entire blower housing from the CPL.
17. Remove the blower housing from the motor.
18. Attached to the motor is the impeller (Fig 2-15). Loosen the setscrew in the center and pull the impeller away from the motor. This will leave the blower backing plate on the motor.
19. Both the blower housing and the impeller may be cleaned according to the preferred method. The blower backing plate cannot be removed from the motor, but it may be wiped clean.

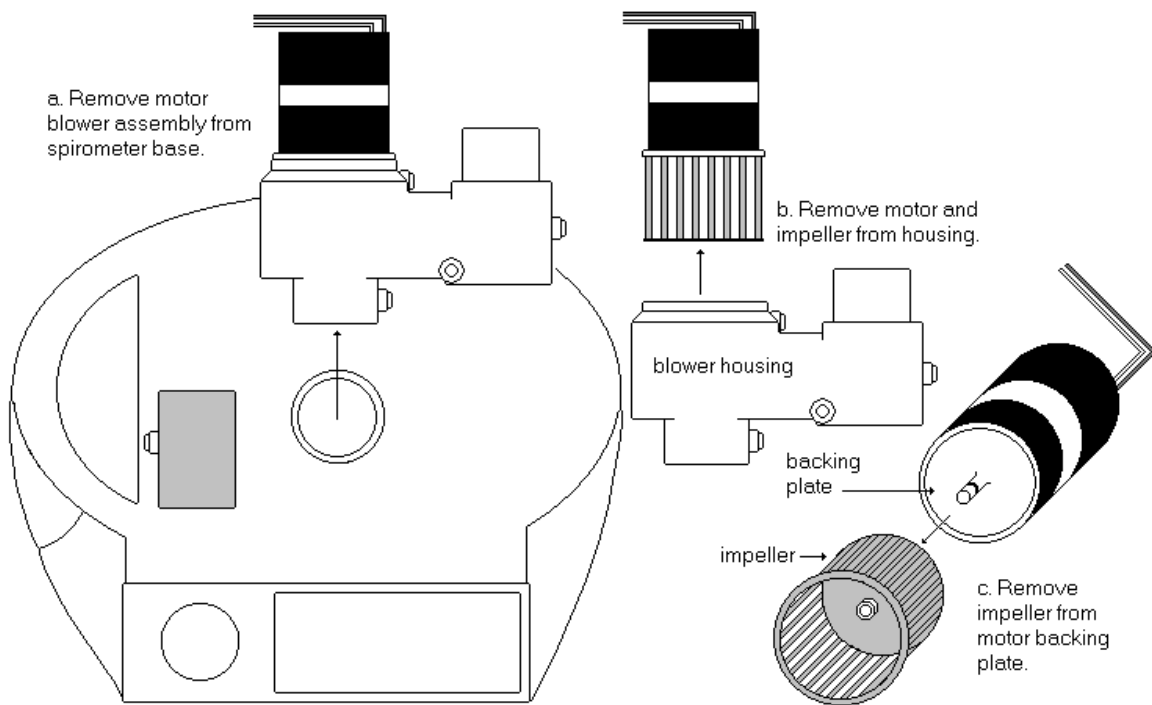


Figure 2-24. Removing Motor Blower and Impeller

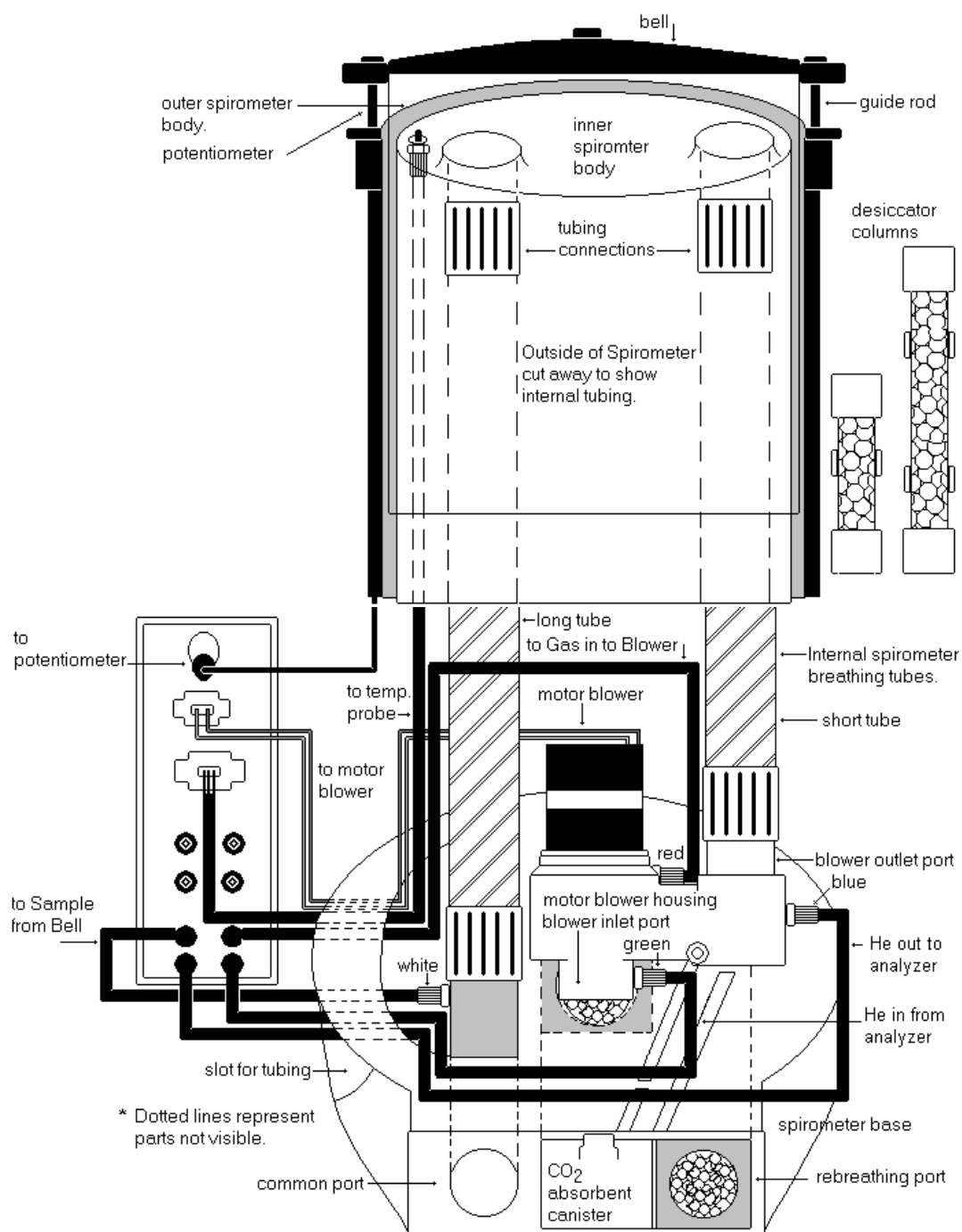


Figure 2-25. CPL Breathing Circuit Components

Reassembling the Breathing Circuit

1. To reassemble the spirometer and blower housing, reverse the above procedure, with the following details in mind.
2. Push the impeller straight onto the blower backing plate rod. Do not turn it as it goes on, as the impeller is self-seating and turning it will loosen it. Make sure that the setscrew is registered on the shaft and that there is about $\frac{1}{8}$ inch between the impeller and the backing plate. Do not have them pushed together.
3. When replacing the motor blower housing, make sure that it is registered, that is, pushed all the way down. If your system has the motor blower bracket, reattach it.
4. Reconnect the tubing and thermistor probe. Then set the spirometer into the base.
5. Be sure to match up the tubing with its corresponding color-coded Luer fittings on the motor blower housing.
6. When reconnecting all Luer fittings, be sure to turn the tubing $\frac{1}{2}$ turn counterclockwise before sliding it onto the fitting. This will ensure that the connection is tight.
7. Reconnect the long breathing tube leading out of the spirometer to the outlet port on the blower housing.
8. Replace the band around the inside body of the spirometer, making sure that it touches the ridge along the top of the inside.
9. To replace the spirometer bell, first find the locating mark on the spirometer body. This mark acts as a guide for installing the plastic base of the dry seal.

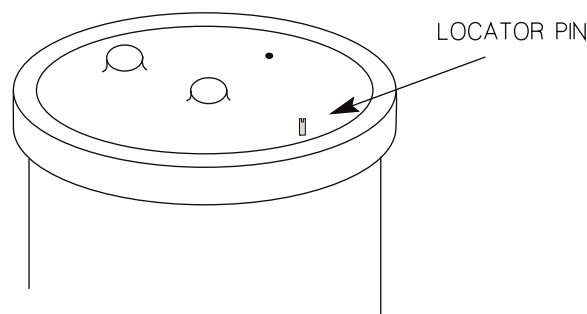


Figure 2-26. Small Locator Mark for Lining up Plastic Ring

10. Place the plastic ring at the base of the envelope over the spirometer body, lining up the slot in the ring with the locator on the spirometer body. Press down on the ring on all sides to secure it.

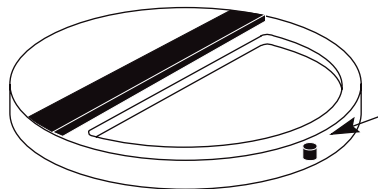


Figure 2-27. Slot on Plastic Ring

11. Twist the bell top to tighten the envelope, then untwist it as the bell is lowered, allowing the bell to slide into the spirometer body.
12. Reattach the bell to the spirometer body by reversing the procedure described in Disassembling.

Seal cut away to show placing the plastic base over spirometer body and lining up the locator slot and the locator mark.

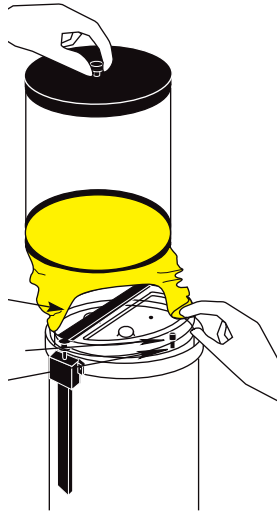


Figure 2-28. Reinserting the Spirometer Bell and Seal

Care of the Collins MicroTach

1. The Collins MicroTach is semi-disposable. Although the MicroTach is durable, there are certain situations in which it will need to be replaced. If you encounter a situation where you cannot verify the calibration, or one in which the MicroTach won't become clean by using the recommended cleaning procedures described below, dispose of the MicroTach and start using a new one. The MicroTach will last longest in situations where clogging of the screen is unlikely to occur, such as in spirometry screening sessions. In situations such as heavy exercise testing, where the screen is more likely to become clogged with saliva, it may be more difficult to clean and therefore require more frequent replacing.

Avoid dropping or banging the MicroTach, as the fittings could become detached. If this happens, do not attempt to reattach them; you must replace the MicroTach.

2. Since the MicroTach is molded in a single piece, there is no disassembly required to clean it. Remove the red and green tubing and clean the MicroTach using the instructions *under Disinfection Procedure for Mouthpieces, etc.*, earlier in this section. Follow the disinfectant manufacturer's instructions for length of soaking. The MicroTach is meant to be soaked and "swished" around in solution, but not scrubbed. Scrubbing the screen may deform it and affect results. Thoroughly rinse and dry the MicroTach, as any residue or water clogging the screen will affect results.

MicroTachs may also be sterilized using a low temperature hydrogen peroxide gas plasma sterilization method such as Sterrad®, by Advanced Sterilization Products, Inc.

NOTES:

If the flow direction on the monitor screen is incorrect, i.e., inspiration and expiration are reversed, make sure that the red and green tubing (at the MicroTach or the CPL User Side panel) have not been switched during recent maintenance or cleaning. Be sure that the green tubing is attached to the MicroTach fitting that is closest to the patient (indicated by a green dot).

The pneumotach must be recalibrated after cleaning due to possible changes in flow dynamics.

Adjusting Regulator Valve Pressure

1. The gas cylinder regulator valves are factory set at an outlet pressure of 50 psi. Although the regulators are factory set, over time they may need adjusting. This may be evidenced by difficulty in calibrating the gas analyzers. Follow the procedure below for making gas tank regulator adjustments.
2. Make adjustments to the gas cylinder regulators as described below, observing the following requirements:
 - a. **All regulator adjustments must be done using a tank containing at least 1000 psi, as measured by the regulator gauge.** A full tank contains 2000 psi; therefore the tank must be at least half full.
 - b. Make your adjustments and measure the pressure coming out of the valve with a pressure gauge. The pressure gauge should be graded fine enough to read 0-60 psi. Be sure to obtain a gauge, which is labeled "Use No Oil".
3. Remove the cap from the end of the regulator body. You will see a hex-headed screw when the cap is removed. (If the cap on your regulator consists of an acorn nut, you will need a wrench to remove it.)
4. Disconnect the regulator tubing from the CPL and attach the pressure gauge to the tubing.
5. Open the tank stem (counterclockwise). The regulator gauge should read at least 1000 psi.
6. Observe the reading on the pressure gauge. If it is not 50 psi, follow the steps below.
7. Close the tank stem.
8. Release the pressure in the gauge by removing the pressure gauge from the regulator tubing. Then reattach the pressure gauge to the tubing.
9. Insert a $\frac{3}{16}$ " Allen wrench inside the hex screw. Turn the wrench counterclockwise until it stops. This is in order to start the adjustment from 0 pressure.
10. Open the tank stem.
11. Slowly turn the wrench clockwise until the pressure on the gauge measures 50 psi.
12. Close the tank stem again.
13. Release the pressure in the gauge by removing the pressure gauge from the tubing. Then reattach the pressure gauge to the tubing.
14. Open the tank stem once more to see that the gauge reads 50 psi. If it doesn't, make adjustments according to the steps above. When finished making adjustments, always check once more to see that the gauge reads 50 psi.
15. Close the tank stem. Reconnect the regulator tubing to the CPL.
16. Replace the cap on the end of the regulator body.
17. Do the same for the other gas tanks if they also need adjusting.

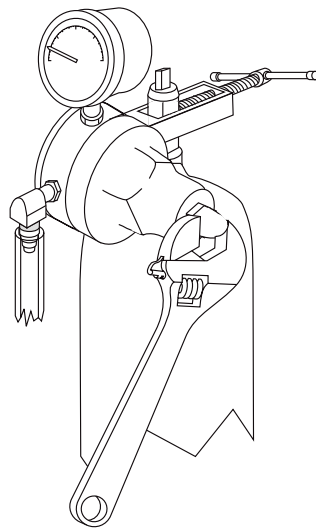


Figure 2-29. Removing the Cap from the Regulator Body

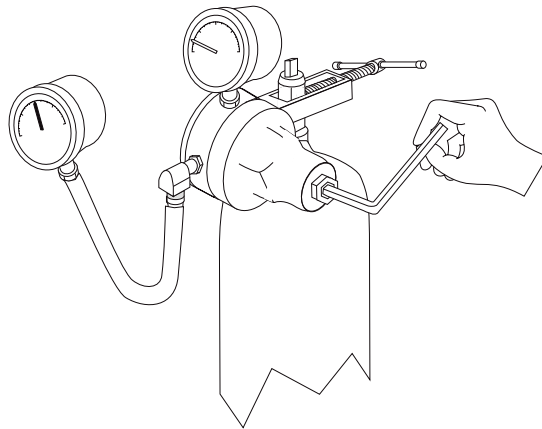


Figure 2-30. Adjusting Regulator Pressure with an Allen Wrench

.SECTION THREE -- TROUBLESHOOTING

This section is designed to help in the event that you encounter problems with your CPL system. It consists of several parts:

- Some basic routines for evaluating and testing the accuracy of certain system components
- A Troubleshooting Guide illustrating some common error sources
- A User Problem Checklist, designed to help you gather information which may be useful to our Customer Support Services personnel.
- Basic theory of the CPL, including pneumatic flow.

WARNING:

WHEN CHECKING AC POWER CONNECTIONS, CABLE CONNECTIONS BETWEEN SYSTEM COMPONENTS, OR FUSES, MAKE SURE THAT THE POWER TO ALL SYSTEM COMPONENTS IS OFF.

Customer Support

If you are having problems with your system that cannot be resolved, contact Collins Medical personnel at:

800-635-3200

or

781-843-0610 and ask for the Customer Support Services Department.

Manuals

Where the problem is likely to be with the computer, keyboard, monitor, or printer, refer to the manuals accompanying these components for troubleshooting advice. For example, if you are having problems with the print format, refer to the printer manual.

Pneumatic Flow through the CPL

Pneumatic flow refers to the flow of air through the CPL for each type of test (spirometry, FRC, DSB). A knowledge of CPL pneumatic circuitry can be helpful in troubleshooting the system.

On the front of the CPL unit are two breathing ports, which are part of two internal circuits leading into the spirometer bell. One port is labeled the *Common Port*, as all 3 types of tests involve this circuit. The other is labeled the *Rebreathing Port*, as only tests involving rebreathing (FRC and optionally, SVC and MVV) employ this circuit. Likewise, the two ports on the rear of the Valve are referred to as the Common Port and the Rebreathing Port. All tubing connections are assumed to be made as described in Section One under *Preparing the System for Testing*. The Common Port has the green dot and the Rebreathing Port has the red dot.

Refer to Basic Theory of the CPL at the end of this section for illustrations and a more detailed description of the pneumatic circuitry.

System Evaluation Routines

On the following pages is a series of system evaluation procedures that can be used as routine checks of the CPL system or in conjunction with troubleshooting steps, when you suspect there to be a problem with the system.

Leak Testing

1. One of the simplest problems to remedy is leaks in the air transport system of the CPL. Signs of an air leak are: the spirometer bell falling when the respective valve is closed, falsely elevated or erratic test results, and failure of the gas analyzers to stabilize. The ATS recommends that leak tests be performed daily and after the CO₂ absorbent canister has been changed.
2. In the first part of these instructions, you will check for leaks in the circuit without the motor blower running; the second part will have you check for leaks with the motor blower running.
3. Have the tubing connected as you would for a test. After the bell is raised, place a #6 solid stopper in the patient port of the valve. If you have a kymograph, place the recording pen on the chart paper. Place a leak detector weight on top of the bell as instructed.
4. Observe the tracing or volume reading. If there is no leak, proceed to the next portion of the leak test, that is, with the motor blower running (#15).
5. If there is a leak, the kymograph tracing and/or volume reading will both fall. If there is no leak, the kymograph tracing will remain horizontal and the volume reading will stay the same. If a leak is detected, you must systematically eliminate portions of the circuit in order to isolate the source of the leak. Stop the kymograph.

NOTE:

After you have found the source of the problem and replaced or repaired the leaking part, always repeat the leak test to make sure there are no more leaks. For example, repeat the leak test with new tubing to make sure it doesn't leak.

6. If the tracing or volume reading indicates a leak, do the following: There are two tubes connecting the valve to the CPL. Disconnect these tubes from the CPL. Insert a #7 solid stopper in the spirometer port and in the CO₂ absorbent canister port. Repeat the leak test. If the leak stops, then it is in the valve or either of the two tubes; proceed to the next step. However, if the leak continues, then it is in the rest of the system; proceed to step 9.
7. Remove the stoppers and connect one of the tubes between the spirometer port and the CO₂ canister port. Repeat the leak test. If the leak continues, then it is in this tube. If the leak stops, then it is in either the valve or the other tube. Connect the other tube between the two ports and repeat the leak test. If the leak continues, it is in this tube. If the leak stops, then it is in the valve.
8. If the leak seems to be in one of the tubes, take it to a sink and fill it with water. Plug each end with a stopper or the palms of your hands; inspect the entire length of the tube for holes or slits, flexing the tube in different directions. Check carefully around the end couplers. If there is a leak, replace the tube and repeat the leak test. Make sure the replacement tube is free of leaks by also testing it with water.
9. If the leak seems to be in the valve, check to make sure that the valve was correctly reassembled after any cleaning or maintenance was conducted. Also run the Balloon Diagnostics file (refer to System Diagnostic Procedures later on in this section) to check the condition of the balloons in the valve. Make sure that none of the balloons have ruptured.
10. If upon stopping the two ports in step 6, the leak appeared to be in the body of the CPL instead of the valve or external tubing, remove the internal spirometer tube from the output port of the motor blower. Insert a solid stopper into the end of this tube. Repeat the leak test. If the leak continues, proceed to step 11. If it stops, then it is in the blower housing or the CO₂ cartridge.
11. Check to make sure the CO₂ cartridge was replaced properly as described under *Replacing the CO₂ Cartridge*. Be sure it has no holes in it.

Check to make sure the blower housing is registered, that is, pushed all the way down.

12. If the leak continues in step 11, check the following for leaks:
 - a. The small neoprene tube connected to the chrome spirometer port. (Opposite end attaches to Sample from Bell port on CPL User Panel). Make sure that the fitting is secure and that the tubing itself has no leaks.

- b. Both internal tubes in the spirometer body. Check in the same manner as you did the external tubing.
 - c. The spirometer bell.
13. To check for leaks in the bell, first remove it as described under *Disassembling the Breathing Circuit for Cleaning*. Invert the bell in a sink and fill it about $\frac{1}{4}$ full with water. Wipe the outside of the bell and inspect it carefully for leaks along the seam and where the top joins the sidewall.
14. If you locate a leak in the bell, you may make a temporary repair using a substance such as Goodyear Pliobond®, which can be purchased at most hardware stores. However, it is recommended that you replace the bell as soon as possible.

CAUTION:

Observe all manufacturer's warnings and precautions for whatever substance you use to temporarily repair the spirometer bell. Be sure to let the adhesive substance dry for at least 48 hours after application, since breathing in the fumes could be harmful.

15. With the bell set up for a leak test as at the beginning of these instructions, observe the bell while conducting the portion of the leak check file with the motor blower running.
16. If the bell rises with the motor blower on, as evidenced by a rise in the tracing or in the volume reading, then there is a leak in the suction portion of the FRC circuit. This is because air is being drawn in and added to the system.
17. If there is a leak, check the 3 neoprene tubes connected to the motor blower housing. Make sure the fittings are secure and that the tubes themselves have no leaks. Repeat the leak test with the motor blower on.
18. If the leak persists, check to make sure there is no leak in the CO₂ absorbent canister, as described in step 10.
19. If the leak persists after all these steps, it may require more advanced Troubleshooting. Contact your Collins Customer Support Services Representative.

Occlusion of a Circuit

At times you may encounter the opposite of a leak, i.e., the occlusion of a circuit. A source of no flow in the FRC circuit could result if you were to forget to reinstall the impeller behind the motor blower housing after cleaning the system. Make sure the system is reassembled correctly, as described *under Reassembling the Spirometer and Blower Housing*.

Troubleshooting Guide

Troubleshooting Scenarios

Following are descriptions of some common error sources and the steps to take in remedying them.

CAUTION:

WHEN CHECKING AC POWER CONNECTIONS, CABLE CONNECTIONS BETWEEN SYSTEM COMPONENTS, OR FUSES, MAKE SURE THAT THE POWER TO ALL SYSTEM COMPONENTS IS OFF.

Problem #1 - Nothing displays on the monitor screen, or the PLUS program fails to "boot up" when the computer is turned on.

Check to make sure that:

1. The power to the computer and the monitor is turned on.
2. All cable and AC power connections have been made as described in Section One. Check in particular the cable connections between the monitor and the computer and the AC power connections for each of these components.
3. There are no broken ribbon cables. Broken cables can cause a variety of problems and it is fairly unpredictable what these will be.
4. The components are plugged into functioning outlets. Test the outlets with a functioning lamp to make sure. For components with detachable power cords, see that the other end of each power cord is plugged into its respective component as well.
5. The monitor brightness and contrast controls are set sufficiently to allow the display to show up.
6. No diskettes are inserted into the floppy disk drive. If a diskette is inserted, the system will try to boot from the floppy drive instead of the hard disk. A *Non-system disk in drive A* error message will be displayed.
7. Try rebooting the system by pressing Ctrl/Alt/Del. If this does not work, turn the power to the system off for 30 seconds; then turn it back on.
8. Check to make sure the fuses, located at the rear of the CPL unit next to the power switch, have not been blown. If they have blown, replace them. If upon replacing the fuses, they blow again, contact Collins Medical, Inc.
9. If all the situations above have been checked, refer to the documentation accompanying your computer.

Problem #2 - When you turn on the power to the system, the monitor display is completely white and remains so throughout the computer boot-up procedure.

Check to make sure that:

1. The computer power switch is on, as the above situation occurs when the power to the monitor is on, but the computer power is not on.
2. The cable connections between the monitor and the computer are made as described in Section One and there are no broken ribbon cables.
3. The computer power cord is plugged into a functioning outlet.
4. Refer to the documentation accompanying your monitor for further details on determining monitor problems.

Problem #3 -The monitor displays a message such as *Communication Error*. This is an indication that the computer and the CPL are not communicating. If such a message were to display, it would be most typically when initiating testing or calibration. Check to make sure that:

1. All power cord connections have been made as described in Section One and that the power to all system components is on.
2. The cable connection between the computer and the CPL is made as described in Section One and there are no broken cables.
3. The fuses are not blown (refer to problem #1).
4. If any of the problems listed above exist, first remedy the situation and then reboot the system by pressing Escape to get to the Main Menu and following the Windows Shutdown procedure.
5. If the problem is not due to any of the above situations, try rebooting the system by pressing Escape to get to the Main Menu and following the Windows Shutdown procedure. If this does not work, power down the system for 30 seconds and power up again, as electrical disturbances, commonly known as "spikes", can cause occasional malfunction of electrical components.

Problem #4 - You are unable to perform testing or calibration operations because the CPL does not respond to user-keyboard action.

1. Make sure the O₂ tank, which runs the valve, is turned on. For example, if it is not on, the valve will not function and therefore the bell won't rise and lower at the appropriate points in the program. A message, *Spirometer should be rising*, will be displayed.
2. Check for the proper tubing, sample line and desiccator column attachments.
3. Make sure the monitor brightness and contrast controls are set sufficiently to allow the entire display to show up. Otherwise a prompt which requires a response in order for the program to continue may not be visible.
4. Check all cable and power cord connections, and power switches. Make sure there are no broken cables. Check the fuses, as described in Problem #1.
5. Try to isolate the problem by finding out which components are not responding. For example, if the volume reading does not change when you lift the spirometer bell, there could be a problem with the linear motion potentiometer on the bell. If none of the components respond, then there is most likely a communication problem.
6. If the problem occurs during a test procedure involving the MicroTach, make sure the patient is breathing through the MicroTach. Otherwise, in some cases, the system will not see flow and the program will not proceed.
7. If the problem persists, reboot the system by exiting to the Desktop and following the Windows Shutdown procedure. If this does not work, reset the power to the system by turning it off for 30 seconds and then on again, as electrical noise may have been the source of the problem.
8. If the source of the problem cannot be located, contact your Collins Service Representative.

Problem #5 - You are unable to attain a satisfactory calibration, i.e., you can't get it to Pass.

1. Repeat calibration, making sure that the entire procedure is performed correctly.
2. If results are still out of range, contact your Collins Customer Support Services Representative.
3. If you are having problems with MicroTach calibration, see the next problem.

Problem #6 - You are unable to attain a satisfactory Pneumotach (MicroTach) calibration; i.e., you can't get it to Pass.

1. In the section about pneumotach calibration, read about the error messages you will get if you do not conduct the procedure correctly.
2. Repeat Calibration, making sure that the entire procedure is performed correctly. If problems still occur, proceed to the next step.
3. Make sure that the MicroTach is clean and undamaged. Check in particular the screen to make sure it isn't dirty. If the MicroTach needs cleaning, proceed with the appropriate instructions in Maintenance. If it is so dirty that it requires scrubbing to get it clean, simply discard it and use a new one.
4. Make sure the MicroTach was reconnected properly after cleaning. If calibration or testing produces negative tracings which should be positive and vice-versa, check to make sure the tubing and pressure taps are matched up correctly, as described under *Caring for the Collins MicroTach*, in Maintenance. For example, if expiration is up and inspiration is down, this is an indication that the tubing has been switched.
5. Also, if the MicroTach is not reconnected properly, a leak in the flow circuit may result. A leak will be evidenced by values below the acceptable range during the slow portion of the 3-part Verify procedure.

When attaching the hoses to the pressure taps, don't twist them on, as this could cause them to eventually loosen. Rather, push the hoses straight onto the pressure taps.

6. After remedying the possible source of difficulty, repeat the calibration procedure. If none of these steps results in successful calibration, contact your Collins Customer Support Services representative.

Problem #7 - You are having problems calibrating the analyzers. Most problems with analyzer calibration are procedural and are therefore easily remedied. If the calibration values are out of range or if any other problems exist, follow these steps:

1. Repeat calibration, making sure that the entire procedure has been performed correctly. If problems still occur, proceed to the next step.

Make sure of the following:

2. That the gas tanks are turned on and that there is sufficient gas and pressure in each tank and in the sample lines leading from them. If all of the above situations check out, the gas tank regulators may need adjusting. This would more likely be the case if you had your system for a long period of time. Refer to *Adjusting Regulator Valve Pressure* under Maintenance for more details.
3. That all gas tank tubing connections are correct and secure.
4. That the sample line is not bent or crimped.
5. That the system has been allowed to warm up for 15 minutes after power-up before performing calibration.
6. Analyzer response and delay failures indicate problems with the sample line. Sample lines need to be replaced every 3 to 4 months.
7. After remedying the source of difficulty, repeat the calibration procedure. If none of these steps results in successful calibration, contact your Collins Service Representative.

Problem #8 - Test results appear unreasonable, i.e., they are either much higher or much lower than expected.

1. Make sure that the system is calibrated properly. The gas analyzers should be calibrated and the pneumotach should be verified prior to each test. Additionally, spirometer calibration should be performed under the following circumstances:
 - a. The first time the PLUS program is run.
 - b. Each day before conducting tests.
 - c. Each time a new version of the PLUS program is installed.
 - d. After disassembly and/or cleaning the spirometer.
2. Conduct a Verify procedure with the spirometer to see that it is measuring correctly. If it is not, repeat calibration, making sure that the entire procedure is performed correctly.
3. Be sure the appropriate calibration is conducted prior to testing, that is, Spirometer calibration prior to the FVC test and microGA calibration prior to DSB testing.

Check to see that:

4. The proper tubing is connected and that there are no leaks in the system. Make sure the tubing between the MicroTach and the CPL is matched up correctly. If the tubing is not correct, expired flow will be read as inspired flow and vice versa. Refer to the Setup procedure in Section One for the correct way to attach the tubing.
5. Make sure that the patient is breathing through the Patient side of the MicroTach and that the opposite end is attached to the correct port on the valve.
6. The pneumotach is clean and undamaged. Refer to Maintenance for instructions on cleaning the MicroTach. If it is damaged or if cleaning would require scrubbing (which could damage the screen), replace it.
7. The patient was wearing a noseclip and he was making a tight seal around the mouthpiece.
8. Setup was correct prior to testing, e.g., gas valves were on, etc..
9. The test was started properly.
10. The test was ended properly.
11. The correct keys were pressed for each operation.
12. The correct preliminary and patient data were entered.
13. The patient performed the test correctly.
14. The correct patient age, height and gender were entered. Otherwise, percentage of predicted results may be distorted.

Problem #9 -The patient's tidal breathing increases in volume and rate during testing for no apparent reason in tests involving the rebreathing circuit.

1. Insufficient scrubbing of CO₂ may be occurring. In this case, the CO₂ absorbent cartridge may need changing.
2. Refer to the Disassembling the Breathing Circuit for Cleaning for recommendations on the frequency of changing the cartridge and for directions on how to do so.

Problem #10 - When the screen indicates that gas is being added to the spirometer, the bell doesn't rise.

1. Check to see that the appropriate gas cylinders contain gas, that their valves are turned on, and that the tubing connections on both ends are secure. If all checks out, proceed to the next step.
2. Check to make sure the O₂ tank for operating the valve is turned on.
3. Perform a leak test as previously described.

Problem #11 - The printer does not respond when a printout is initiated from the keyboard.

Check to see that:

1. The power to the printer is turned on.
2. The printer is in the on-line mode.
3. The printer AC power cord is plugged into an appropriate outlet.
4. The cable connections between the printer and the Computer are made as indicated in Section One.
5. Make sure that the printer is configured for the correct print functions. Refer to your printer manual for how to set these functions.
6. Refer to the printer manual for more details on printer malfunction.

Problem #12 - Pressing the End key or the Arrow keys on the numeric pad produces numerical data on the screen instead of the desired action.

If this is the case, most likely the Num Lock key has been pressed inadvertently, thereby activating the numeric functions of these keys. To rectify this situation, press the Num Lock key. The non-numeric functions of these keys will thus be restored.

Problem #13 - You have a microGA analyzer for conducting real-time diffusion analysis and you receive the following type of message during the DL test or microGA calibration:

MG COMMUNICATIONS ERROR

If you receive this message, exit the testing or calibration module and re-enter. If this fails, reboot the system. If the problem still is not solved, call the Customer Support Department at 800-635-3200.

Problem #14 - The quick-disconnect end of the gas tank regulator tubing keeps popping off.

1. Trim the end of the tubing for a tighter fit.
2. Check the regulator valve pressure and adjust if necessary.

NOTE:

Do NOT secure the end of the Tygon tubing attached to the Luer-lock fittings with tie wraps or any other type of clamp. If the pressure does increase, it is preferable to have the tubing pop off on the outside, where it is accessible. If the tubing were to be clamped, the pressure buildup could cause the tubing to pop off internally, making it very difficult to locate. Instead, follow the steps given above.

Isolating the Problem - a General Guide

1. If you encounter a problem that does not fit one of the scenarios just described, it is helpful to at least be able to determine whether the problem is with your computer or with the CPL unit.
2. If you are having problems with a particular component on the CPL, such as the vacuum pump, most likely the problem is with the CPL hardware associated with this component. However, if none of the CPL components work, and all power cords are plugged in, power switches are turned on, cables are secure, and fuses are intact, then most likely the situation is a communication problem between the CPL and the computer. Contact your Collins Service Representative for assistance.
3. If you receive a communication error on the monitor screen, most likely the problem is between the CPL and the computer. Check all cable, power cord connections, power switches, and the fuses as previously described.
4. Once you have isolated the general location of the problem, you can then refer to the appropriate scenario in the Troubleshooting Guide. If the problem still cannot be found, communicate all the information gathered to your Collins Customer Support Services Representative.
6. For some problems where test data is not threatened, it may be helpful to reboot the system. If this does not work, power down the system for 30 seconds and then power up again, as electrical noise may be the source of the trouble.

User Problem Checklist

1. If a user suspects there is a problem with the CPL system, first determine:
 - a. Is it a fault within the system or is it a problem with the patient or a test procedure?
 - b. Is the test being conducted as described in the instruction manual?
 - c. Is the system set up as described in the PLUS and the CPL manuals?

2. Then, define the problem as specifically as possible. For example:

- a. Are the test results inaccurate? Which test? Are the results greatly exaggerated?
 - b. Does the system have any leaks?
 - c. Is the problem electrical in nature? (Circuitry, lights, computer, power cords, etc.)

NOTE:

If you get water on or near the electrical circuitry, power down the system immediately and unplug all AC power cords from their outlets. Do not reapply power until all water or moisture is completely eliminated. Contact Collins Medical, Inc. if necessary.

- d. Is the problem mechanical in nature? (Spirometer bell problems, potentiometer problems, printer problems, monitor problems, valve or canister problems, etc.)
 - e. Is the problem in the pulmonary software? (The Collins-supplied Program Disks.) Was the program loaded correctly?
 - f. Were the questions in the Configuration program, especially the hardware section, answered correctly?

3. Next, perform the following simple system checks:

- a. Is the electrical power to the system turned on?
 - b. Are all system component power switches turned on?
 - c. Are any fuses blown? Are there any loose connections?
 - d. Is the proper tubing connected to the spirometer? Does any of the tubing leak?
 - e. Was the system set up properly before testing began?
 - f. Did the test start properly, according to the manual?
 - g. Did the test end properly, according to the manual?
 - h. Was the correct patient data entered? Was the data entered into the computer properly?
 - i. Was the wrong key pressed?
 - j. Did the patient perform the test exactly as instructed?
 - k. Did the operator perform the test as described in the manual?
 - l. Was the system calibrated correctly?
 - m. Is there any clue as to why the test results are inaccurate? (Recent calibration or maintenance, for example.)
 - n. Were there any changes to the system since the last test was conducted?

4. Now, list all possible details relating to the suspected problem, including but not limited to:

- a. Temperature of spirometer; barometric pressure of the testing room (especially for areas at altitude.)
 - b. Patient's height, weight, age, sex, race.

NOTE:

Beware of misassigning height or weight units, as this will cause inappropriate predicted values to be calculated. Let's say, for example, that in the Patient Information program, you were to enter a height of 66 in the *centimeters* box whereas you had intended to enter it in the *inches* box. The program would interpret the height to be 66 centimeters and the predicted values would be incorrect.

- c. Type of test in question, if known. (Save a printed copy.)
 - d. Any modifications, maintenance, or calibration performed on the system since the last correct test results were obtained.
 - e. All calculations performed, if available (Attempt to manually calculate the test results to compare with the suspected inaccurate computer-provided results).

- f. The exact sequence of steps that led to the problem. Can you cause the event to occur repeatedly? Make a note of the exact procedure used, including keystrokes and handling of the equipment.
- g. All miscellaneous aspects of the suspected problem.

5. If the source of the problem is found:

- a. Can it be fixed without outside help?
- b. Is enough information available to discuss the problem over the telephone with a service representative?
- c. Is an on-site visit from a service representative necessary? (If in doubt, call Collins Medical on the telephone first.)

6. Finally, if the source of the problem cannot be determined:

- a. Is all possible information about the problem written down and available? Could someone else understand this information if the usual operator were not available?
- b. Is enough information available to precisely describe the problem over the telephone to a service representative?
- c. Is all relevant information written down legibly for a service representative to evaluate on-site?
- d. Has everything been double-checked?

7. When calling Collins Medical, Inc. for Service or Technical Support (800/635-3200):

- a. Identify the type of system you have. Make sure you know the following:

- Your Customer Number

- The type of computer in your system

- The program name (e.g., PLUS) and version (e.g., PLUS 2000, ver. 4.0). To find the version number, click on *Help*, then *About....*

- The serial number of your CPL

- b. Have all information regarding the problem. Let the technician know the error messages you are getting and when they occur, if applicable. Describe what you were doing when the error occurred and the steps you have taken to attempt to solve the problem.
- c. Call from a telephone at or near your computer. You may be asked to type some commands at the keyboard, or make minor adjustments, relay detailed information during operations, or try other troubleshooting steps at the system itself.
- d. For all third party software, such as Lotus 1.2.3, QuattroPro, Excel for Windows, etc., contact the manufacturer of that particular software for troubleshooting advice.

Supplies Listing

Accessories and Disposable Items

For more information, refer to our website at www.collinsmedical.com.

Supply #	Item Name
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003500	MicroTach, Single
003505	MicroTach, package of 3
022380	Bronchial Challenge Kit (5 Nebulizers)
021156	Calibration Syringe, 3-liter
021501	Disposable Desiccant Column
022551	3 lb CanisterCO ₂ Absorbent Granules
381248	DLCO Replacement Nafion Tubing
022556	CO ₂ Absorbent Pack (package of 6)
022025	Kymograph Paper - Millimeter
022411	Recording Pens, Red; Package of 5
022413	Recording Pens, Black; Package of 5
022220	Tubing, Internal Spirometer to CPL Port
022222	Tubing, Internal Spirometer to Blower Outlet Port
370082	Kymograph Drum
700597	Spirometer Bell, Dry-Sealed

Filters and Mouthpieces

022450	DC-2 Filter
	022452, box of 24
	022454, box of 100
	022456, box of 400
022458	DC-2 Filter and Disposable Comfort Fit Mouthpiece
	022460, box of 24
	022462, box of 100
	022464, box of 400
022465	Disposable PFT Kit, includes, DC-2 Filter, ComfortFit Mouthpiece and Soft Noseclip, box of 100
022242	Disposable Comfort-fit Mouthpiece
02240x	Disposable Cardboard Mouthpieces
021231	Disposable Soft Noseclip

for Balloon Valve

700885	Replacement Balloon Kit for Valve (all four balloons)
	024010 B1 Balloon (white)
	024011 B2 Balloon (Red)
	024012 B4 Balloon (Blue)
	024013 B6 Balloon (Black)

Gasses

022610	Helium 100% in Disposable E-Cylinder
022663	Rapid-Response DLCO Gas Mixture in Disposable E-Cylinder
022600	Oxygen in Disposable E-Cylinder
022950	H Regulator CGA 540 for Oxygen with Conversion Kit
022951	H Regulator CGA 580 for Helium with Conversion Kit
022952	H Regulator CGA 500 for CO Mixture with Conversion Kit
022919	Circular Hand Wrench for Opening Gas Tanks

Tools, etc.

021525	Leak Tester, Bronze
390246	Allen Wrench, for Disassembling Spirometer
022975	Dow Corning #7 Compound (Silicone Grease), 5.3 ounce tube
670013	#7 Solid Stopper
670001	#6 Solid Stopper

References

1. (ATS guidelines for infection control)
American Journal of Respiratory and
Critical Care Medicine, Vol 152, No.6,
pp. 2188 -2189, December 1995.
2. (AARC guidelines for infection control)
AARC Clinical Practice Guideline - Spirometry,
1996 Update, reprinted from Respiratory Care,
Vol 41, No. 7, pp. 629-636, 1996.

BASIC THEORY OF THE CPL_{pf}

1. The Collins CPL_{pf} system consists of instrumentation for performing pulmonary function testing, specifically, FVC, MVV, Lung Volumes and Diffusion Capacity.
2. Following are some major components of the CPL_{pf}.

Spirometer: Stead-Wells, dry-seal, 10-liter spirometer for measuring flows and volumes in pulmonary function testing.

Balloon Valve: Automates a variety of pulmonary function test procedures.

MicroTach: Allows pneumotach-based spirometry with the CPL. Measures flow directly and integrates flow to arrive at volume measurements.

Residual Volume (RV): Allows He dilution method of measuring lung volumes.

microGA Multiple Channel Analyzer: This analyzer measures the amount of CO₂, CO, and CH₄ in each patient breath or in the calibration gas during Diffusion testing.

MIPS/MEPS Components: Allow determination of maximum inspiratory and expiratory pressures.

Dosimeter: Allows computer-controlled dosimetry for bronchial challenge testing.

Spirometry

Typically, a pulmonary function system is equipped with either a pneumotach or a spirometer, or both. Figure 3-1 shows a cross-section of the breathing circuit in a stand-alone spirometer to aid you in understanding how a spirometer works. With a spirometer, measurements of basic lung volumes and capacities are made as follows:

As the patient breathes through the mouthpiece (A), the expired (or inspired) gas flows through the breathing tube and the internal tubing (B and C). The expired gas empties inside the spirometer bell (D) and forces it to rise. Traditionally, the bell-mounted recording pen (E), moving with the bell, records the breathing maneuver on a kymograph, which is a revolving drum containing chart paper (F). With a direct-writing spirometer bell, such as the one used in the CPL system, an inspiration is recorded as a downstroke and an expiration as an upstroke. The Collins CPL spirometer is equipped with a dry seal attached to the bell to prevent air from escaping from the bell.

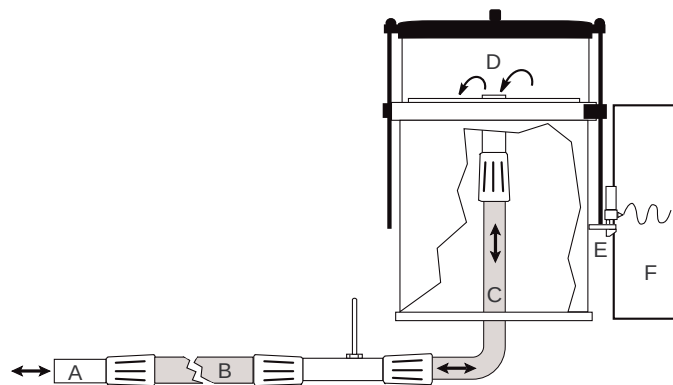


Figure 3-1. Cross-Section of the Breathing Circuit in a Stand-alone Spirometer

Instead of a kymograph, or in addition to one, many spirometers today are equipped with a linear motion potentiometer. This electronic device is attached to the bell and thereby provides an output voltage that corresponds to the movement of the bell. In this way, bell volumes can be read and calculated by a computer connected to the spirometer. The Collins CPL with Spirometer contains such a spirometer/potentiometer/computer system for making measurements of basic spirometry

parameters, such as Forced Vital Capacity, Slow Vital Capacity, Maximum Voluntary Ventilation and for calculating lung volumes.

During spirometry maneuvers with the CPL spirometer, the patient breathes through the balloon valve and connected tubing into the common port. The expired air passes directly into the spirometer bell via the common circuit. When the patient inspires, air passes from the spirometer bell, back through the common circuit, and into the patient's lungs.

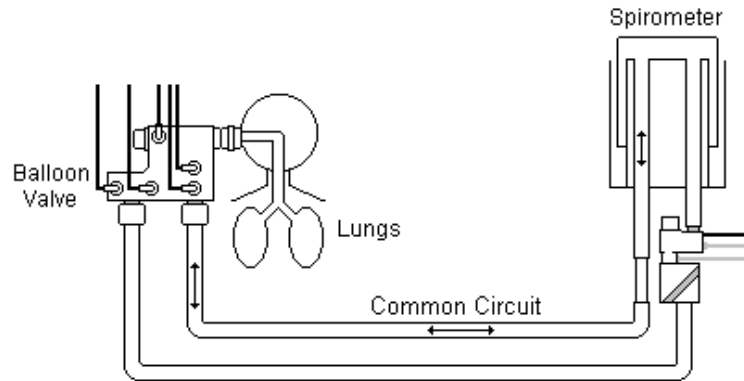


Figure 3-2. Illustration of the Spirometry Circuit in the CPL

NOTE:

An alternate way to perform the SVC and MVV maneuvers is to use the rebreathing circuit. The path of airflow will be the same as that described below for FRC, minus the sample circuit.

The CPL Balloon Valve automates a variety of pulmonary function test procedures (such as raising and lowering of spirometer at appropriate moments during the test sequence, making the correct circuit available for any given test, etc.).

Spirometry measurements can also be made with the use of the pneumotach (for the CPL, the Collins MicroTach). The patient breathes through the pneumotach, which is a device that measures flow across a flow-resistive element, in this case, the pneumotach screen. The inspired or expired flow reading is then integrated into a volume reading with the aid of a computer.

The MIPS/MEPS feature in the CPL allows the user to make measurements of the patient's maximum inspiratory pressure and maximum expiratory pressure through the use of a pressure sensor in the module. These terms refer to the maximum pressure attained by the patient during either inspiration or expiration.

Lung Volumes

The Spirometry and RV components in the CPL allow for measurement of lung volumes in addition to simple spirometry. Several key lung volumes are defined below:

Tidal Volume (TV): The volume of air breathed in or out of the lungs during normal breathing.

Functional Residual Capacity (FRC): The volume of air left in the lungs at the end of expiration during normal breathing.

FRC is composed of the following two volumes:

The **Expiratory Reserve Volume (ERV):** the maximal additional volume of air that can be exhaled following a normal expiration to FRC.

The **Residual Volume (RV):** the volume of air remaining in the lungs at the end of a maximal exhalation.

While most lung volumes can be determined via simple spirometry, RV cannot be measured directly via spirometry. Instead, FRC is determined by indirect means and RV is arrived at by subtracting ERV from FRC.

The CPL offers two methods of measuring FRC. One is via the body plethysmograph, which is not included in this particular discussion. The other is the closed-circuit helium dilution method available with the CPL Residual Volume instrumentation. Refer to Figure 3-3. This method involves the dilution of helium, an inert, soluble gas, as it mixes with the air in the lungs. To begin with, the spirometer is filled with a mixture of approximately 10% helium in air. At exactly the end-expiratory level, the patient starts breathing this mixture from the closed spirometry system. As the helium mixes with the additional air in the lungs, it becomes more dilute. Since helium does not cross the alveolar-capillary membrane, the volume of helium remains the same during the test period. Therefore, the initial concentration ($He_{initial}$) multiplied by the volume of gas in the spirometer at the start of the test ($V_{spirometer}$) equals the final concentration of helium (He_{final}) multiplied by the volume of gas in the spirometer at the end of the test plus the volume of air in the lungs, which is FRC. The equation can be written and solved for FRC as follows:

$$He_{initial} \times V_{spirometer} = He_{final} \times (V_{spirometer} + FRC)$$

$$FRC = \frac{V_{spirometer} \times (He_{initial} - He_{final})}{He_{final}}$$

During the FRC test, both the common and the rebreathing circuits are used. At the end of a tidal breath, the appropriate portion of the valve opens, thus connecting the patient to the internal FRC circuitry. The motor blower is on and its accompanying valve is open. Air from the patient's lungs is directed by the motor blower through the valve, through the CO₂ absorbent canister, past the blower, into the spirometer, and out the common port to the patient. A portion of the air is directed through the helium analyzer and back to the blower. The gas mixture passes through the system and the patient's lungs until equilibration has occurred.

The O₂ consumed by the patient during the test is replaced by automatically adding O₂ to the spirometer bell. The balloon valve, in conjunction with the CPL, makes various gasses (O₂, Helium, room air) available to the spirometer as required by the program. The excess carbon dioxide expelled by the patient is absorbed by the container of CO₂ absorbent canister the breathing circuit. The concentration of helium in the system is determined by use of a helium meter. The above calculations are conducted very rapidly with the CPL system's PLUS software program and the computer.

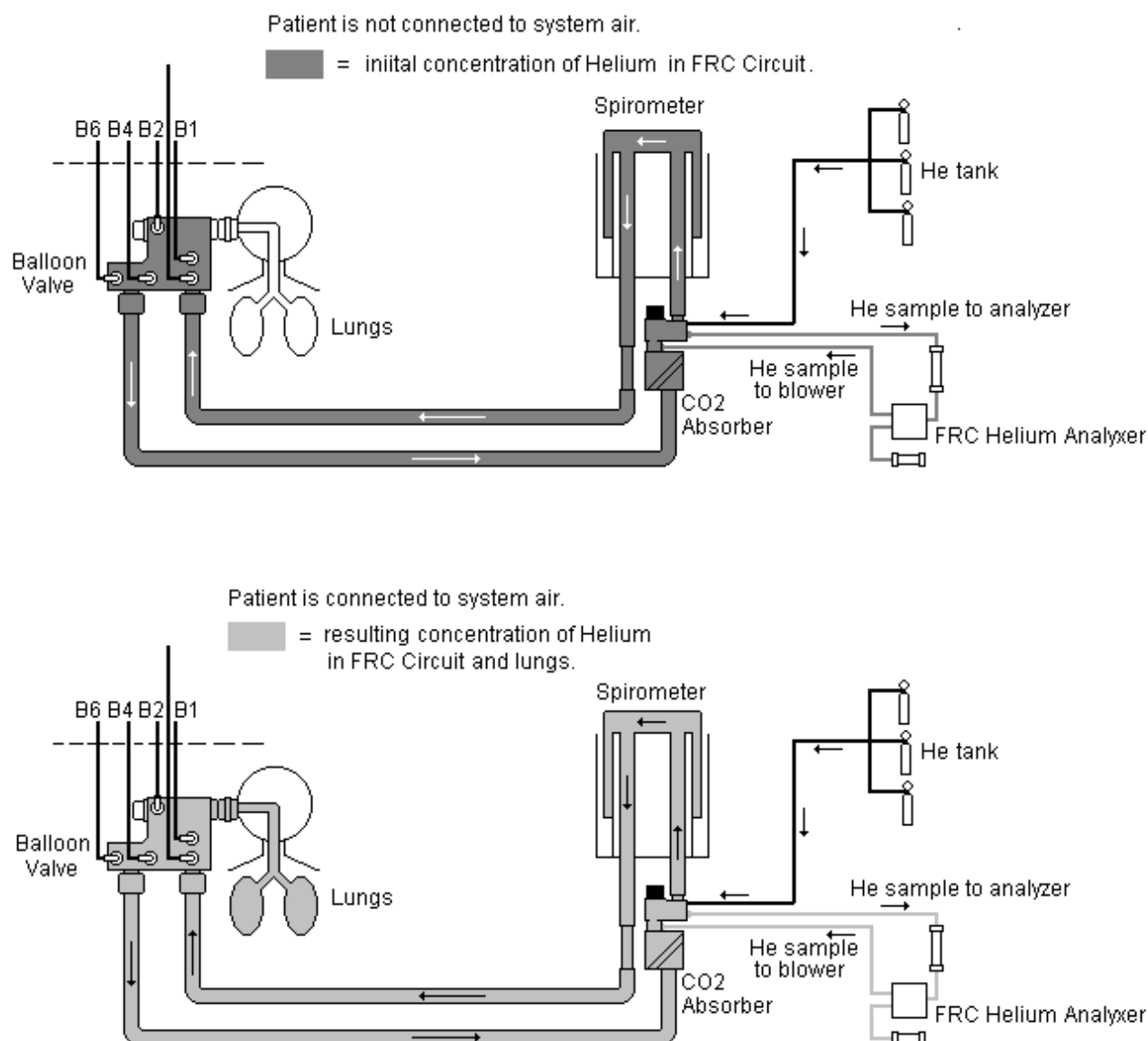


Figure 3-3. Illustration of the Helium Dilution Method of Arriving at FRC with the CPL

Diffusing Capacity

Diffusing capacity of the lung is a measure of the lung's ability to diffuse O_2 from the alveoli to the capillary blood and CO_2 from the capillary blood to the lung to be expired and removed from the body. Diffusing capacity is reduced when alveolar walls are destroyed and pulmonary capillaries are obliterated by emphysema and when the alveolar-capillary membrane is thickened by edema, consolidation, or fibrosis. The method used by the DL module to determine diffusing capacity of the lungs involves the use of carbon monoxide (CO), since it has diffusing characteristics similar to those of O_2 and because of the great affinity of hemoglobin for CO. There are several methods available for measuring the diffusing capacity of the lung for CO (DL_{CO}). The Collins DL module uses the single-breath method. In this method, the patient takes in a very low concentration of CO in a single inspiration and follows this by a 10-second breath-holding period. He then exhales and the expired fraction of CO is measured using an infrared CO analyzer, the concentration of gas in the lungs is determined via the dilution of CH_4 during the single breath maneuver, and the rate of carbon monoxide uptake from the lung is calculated by the software.

In the Collins CPL system, the microGA Rapid Response Analyzer method of measuring gas fractions during lung diffusion testing has eliminated the alveolar bag previously used for sample collection in the conventional diffusion method. With the

microGA method, methane (CH_4) is used in place of helium as a tracer gas. A tracing of gas concentrations during the maneuver is displayed along with the volume tracing, thereby allowing the user to determine where washout occurred and sample collection began. Using the microGA analyzer increases the accuracy of gas measurements and allows the user to visualize the point where washout is complete. The same equations are used for determining DLSB as for the conventional method; however, CH_4 is substituted for He.

The sample analyzed to determine DLCO is collected from the stored realtime data. Washout, sample volume, and sample window position can be modified anytime the patient's data is reviewed.

The microGA diffusion circuit consists of the spirometer, the common port, the spiral tubing and the valve. For the diffusion test, the spirometer is first flushed and filled. The analyzer is then calibrated for zero and gain. During inspiration, the patient draws test gas from the spirometer bell, through the common port, the connected tubing, the valve, and into the lungs. The patient exhales back into the spirometer bell at the end of the breath holding time. During the entire test time, the pump draws a sample from the valve, through the Nafion tubing (which equilibrates all gas to room relative humidity), through the analyzer and then back into the spirometer to maintain system volume.

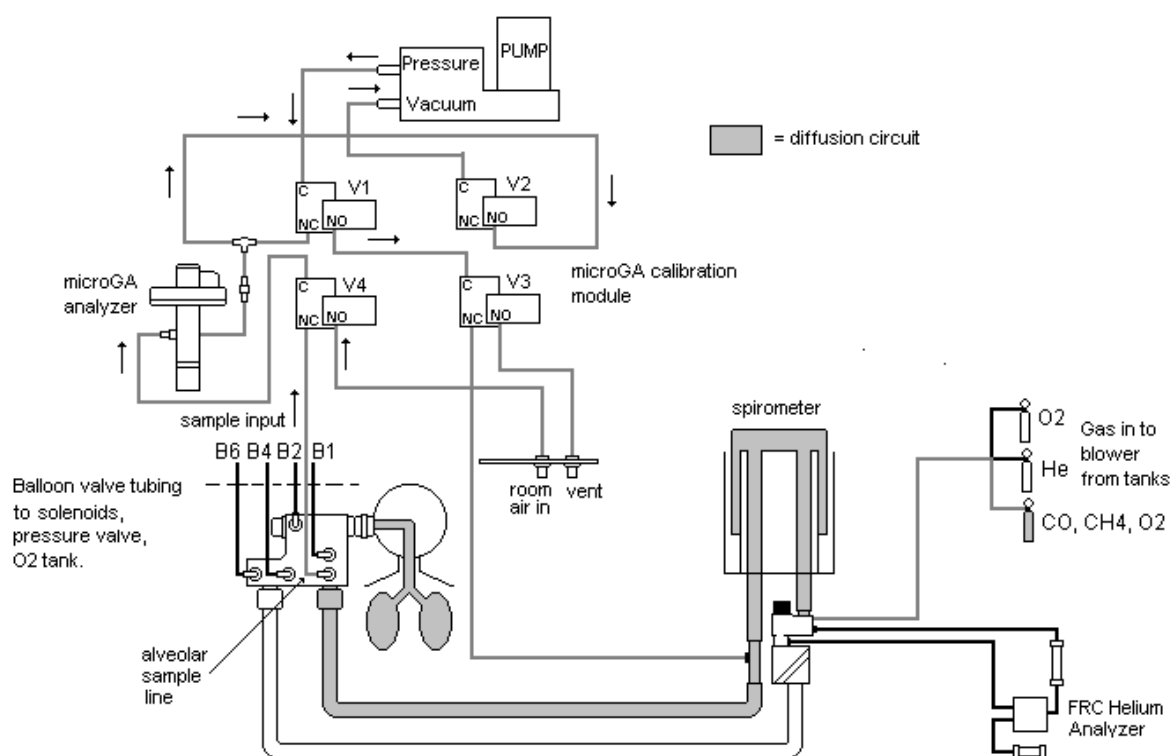


Figure 3-4. Illustration of the CPL Diffusion Circuit with the microGA Analyzer



Collins Medical, Inc.
220 Wood Road
Braintree, MA 02184-2403
(781) 843-0610 (800) 225-5157
FAX (781) 843-4024
www.collinsmedical.com